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ENVIRONMENTS[1]

By Professor BURTON E. LIVINGSTON

THE JOHNS HOPKINS UNIVERSITY

THE honor of being here this evening as retiring president of the most dignified of our American biological societies is greatly appreciated, and this occasion is for me a very pleasant one indeed. I am specially glad to be allowed to represent the relatively youthful science of plant physiology on the occasion of this semi-centennial celebration of the American Society of Naturalists. With Dr. Conklin's inspiring story of the first half-century of our society fresh in our minds, it is not unnatural for us naturalists to ponder over phases of the probable future of biological science, as its future may be tentatively foreseen from recent thought trends in this field, and it is to some phases of the newer trends that I wish to ask your attention.

For the last decade or two one notable growth change in biological view-point has been a rapid increase of interest in processes and products of living things, as these may be studied and compared in an increasingly quantitative way. Observations become progressively more comparative, and more quantitatively so. Superficial description must, of course, precede everything else, but comparison calls for increased precision of factual knowledge and consequently observation has become, and is becoming, continually more precise and more laborious. This kind of progress is seen partly in the introduction of new characteristics or dimensions, according to which things may be more satisfactorily compared, and partly through improved methods of observation and mensuration. Our language is expanding, with added words and phrases calculated to facilitate precise notation, but such additions hardly keep pace with the recent rapid advance of thought, and some new concepts are widely accepted without adequate ter-

[1] Presidential address presented before the American Society of Naturalists, at its Boston meeting, December 30, 1933.

minology, being represented in some instances by nothing more suggestive than letters of the alphabet. As just one familiar example, consider hydrogen-ion concentration (or hydroxyl-ion concentration) of body fluids and environmental media. This surely important characteristic of solutions was undreamed of in the biology of thirty years ago, but measurements of it have already been recorded for almost every sort of aqueous solution with which biologists deal. Improved methods, for its more precise measurement, are continually being brought forth. Other ion concentrations are beginning to receive attention. Oxidation potential promises soon to play an important rôle in many biological discussions.

Recent progress has involved, among other things, increasing emphasis on the physiological aspect of biology, which deals primarily with processes, changes or transformations that occur in organisms. The etymology of the word "physiology," like that of the word "nature," suggests growth and change. We tend more and more to study and compare developmental and metabolic processes and to institute comparisons and discover relations among all these and between them and the concurrent environmental processes.

The primary measurable characteristic of any specified process is obviously its time rate, and comparisons between different occurrences of the same process are increasingly made in terms of their rates. For example, the simple proposition that green leaves generally give off oxygen and absorb carbon dioxide by day, but generally give off carbon dioxide and absorb oxygen by night, was something worthy of discussion in the earlier days of the last century, but that proposition now arouses no opposition and present interest in it centers about the different and fluctuating rates at which these absorptions and eliminations occur. Recent studies deal with acceleration and retardation of these rates, with the various influences that accelerate or retard them and with accounts of how they fluctuate differently for different forms of green plants or for different developmental stages of the same form. We are even beginning to compare rates of acceleration or deceleration; that is, rates of change of rates of change. The time factor thus becomes increasingly important in experimental and observational studies.

To secure useful descriptions of cells, tissues, organs or organisms, it is usually necessary to give quantitative attention to several different kinds of characteristics or dimensions, according to the sort of comparisons we propose to make. Size, shape, weight and color are perhaps the simplest of these. Anatomical, histological and cytological characters may come next, or our proposed study may lead us to the quantitative estimation of various chemical contents, such as dry weight, nitrogen content, and so on. Finally, rates of metabolic change (such as carbon-dioxide production, for instance) may be the things we wish to compare. If no other means were available one might, I suppose, distinguish between active men and active mushrooms in terms of their respective respiration rates per unit of body weight, body volume, etc., under some suitable standard set of environmental conditions.

It is generally necessary to employ several different sorts of dimensions or characteristics at once. Thus, two men may be compared with respect to body weight, stature, skull shape, complexion, eye color, basic metabolism and the results of intelligence tests; or two apples may be compared with respect to size, shape, color, toughness of skin, water content, sugar content, flavor, keeping qualities, respiration rate, and so on.

Of course you are familiar with all these things and with an exceedingly great variety of related things not mentioned here, but it may not be amiss to point out that, although comparative evaluations based on one sort of criteria may be markedly different from those derived from the study of another sort, yet both sets of conclusions may be quite significant and reliable. It is obviously essential to specify just what criteria are employed when we compare different organisms or when we compare an organism at one time with the same one at another time. To illustrate, one plant may be enlarging more rapidly than another, but the latter may be concurrently producing starch or resin more rapidly than the former. In general, we may note that many apparent discrepancies among published scientific observations seem to be at least partially related to the employment of more or less different criteria for the evaluation of the same thing by different students. The criteria used, whether they are static or dynamic, and the procedures by which their magnitudes are estimated for comparative studies require more specific description than is generally given in our contributions. You will probably all concur with me in this last remark, unless perchance you may be the editor of a scientific journal in these times of increased writing and decreased financial income from subscriptions, when brevity of statement seems to be more desirable than clearness and logical completeness.

Thus far we have been considering organisms and their parts, which may be embraced by the term "internal conditions"; that is, everything that pertains to the organism as distinct from its surroundings. These are the taxonomic, evolutional, morphological, ecological, physiological and sociological characters by means of which we judge and compare our organ-

isms and their various performance or behavior patterns. They may represent simple static observations of *being*, with reference to specified developmental stages—as when we say that the leaves of some plant form are opposite, lanceolate, crenate, stipulate; that horses have four legs; or that yeast cells are ellipsoid. On the other hand, they may represent dynamic characteristics, involving rates of change and their fluctuations—as when we say that some plant is biennial under a specified range of climatic and soil conditions, that a wild duck is fleet of wing when in good health or that an experimental organism was observed to produce carbon dioxide at a specified rate during a specified period of its individual life.

With those considerations in mind, I wish now to turn to my announced topic, "environments." We may remark at once that the spatial division of the universe into organism and environment is arbitrary in many instances, although such division is quite necessary. For example: Is an object held tightly in my clenched hand internal or external to my body; what of the contents of the alimentary canal; what of the fluid lining of the lung cavity? Are the gases of the intercellular spaces in an ordinary leaf to be regarded as internal or external; what of the liquid commonly found in the cavity of a leaf of the Sarracenia pitcher plant? The answer to such questions naturally depends on the nature of our interest, on the problems in hand, but it is always true that many features of an organism are continuous with corresponding features of the environment; there is always interchange of material and energy between these two portions of a more complete system, and organism influences environment while environment influences organism. Consequently, we can not expect to proceed far toward an appreciative understanding of the ordered vital weft of internal features without giving equal attention to numerous features of the just as thoroughly ordered but different environmental weft. In all our discussions the environment is to be consciously considered or at least tacitly recognized; in all our experiments the environment lurks behind the scenes, as it were, ever ready to baffle our efforts and always calling for very watchful alertness on our part. Whether we are studying protoplasm or cells or tissues or organs, whether we are interested in individual organisms as such or in social groups like plant and animal societies, this generalization holds.

Unrecognized or unmeasured environmental influences may play rôles of which we have not yet even dreamed. The same is of course equally true of internal influences that are not adequately recognized and evaluated, but I think these are apt to receive much more attention than is usually given to the possible influences of environmental unknowns. Such apparently surreptitious influences, whether internal or external, may be to blame for many or most of our uncertainties, they seem to inhabit the realm of chance or fortuity, sometimes giving rise to mysticism, wishful thinking and various pseudo-scientific ideas and statements. You can recall many instances where study of a newly recognized environmental feature has recently cleared up, in large degree, an outstanding problem. Think, for example, of osmotic pressure, hydrogen-ion concentration, colloidal relations of sol and gel, the micro-organisms of the soil, the boron and copper concentrations of natural waters. The bringing forward of hitherto unappreciated influences greatly increases the complexity of a problem, but the complexity of a problem must surely be appreciated before satisfactory scrutiny can be applied. We are well used to investigations that first render our discussions more difficult.

Not that we should study organisms less but that we should study environments more, that is my present theme. We know enough of vital processes to realize that they are exceedingly complex, but that complexity is everywhere related to another sort of complexity that is manifest in the outer world. The two are to be studied together.

As ecologists of all sorts easily realize, the environment of an organism embraces the whole universe excepting the organism itself. Our present problems would be greatly simplified, however, if we might proceed outward from the organism only a very short distance, studying immediate or proximate environments not primarily for themselves and with regard to their origins and evolutions, but for their influence on living things. We need especially to try to envisage the structural and performance patterns of a very thin environmental shell, which lies externally against the organism's periphery. This is sometimes called the micro-environment. But we find it difficult, or at present impossible, to confine our attention to that limited region, for we have generally not yet learned how to investigate the microcosmic conditions that prevail there. Therefore, we are constrained to direct our explorations somewhat farther afield, into regions where we are now able to carry on. So we usually study phenomena that do not influence our organisms directly but do influence their immediate surroundings, which in turn influence the organisms. We need to avoid going too far afield, however; a biologist studying environments may do well to keep always, or at least intermittently, in close touch with his biological problems. Soil science and climatology, for example, are largely devoted to discussions that do not impinge directly upon ecology, horticulture, agronomy, but some portions of these sciences of soils

and climate do lie clearly within the biological purview and are of very great importance there.

Limitations of my own ability and of my time preclude any attempt to give special attention here to the consideration of organs and tissues, whose immediate environment is other cells and tissues of the same organism, but I think the same principles would be found to apply in the study of the internal microcosm as in that of the external one. I am aware of a great realm of physiological and cytological problems away from which I must turn my face for the present. I am confining myself largely, as you see, to studies of the organism as a whole and of its performance patterns as these are related to the surroundings.

How do we attack the study of environments and how may our campaigns of attack be improved? Of course, we first try to describe our environments, employing, as far as we can, characteristics that promise to show kinds and degrees of environmental influence. In many instances we seem to select for our description environmental characteristics that others have employed before us, or we employ those that appear most easily described. In some instances the invention of a new instrument or method for measuring some environmental condition leads to a vogue or fashion. In taxonomy and field ecology we are constrained to consider only environmental conditions that may be pictured with the least amount of trouble and with the simplest kinds of instrumentation. In partially controlled experiments we use more precise and correspondingly more troublesome methods for environmental evaluation. Such descriptions should of course be adequate for the quantitative comparison of one environmental complex with another and for the comparison of environment with organism.

It is usually convenient to consider the environment of an ordinary plant (with roots in soil and stems and leaves in air) as divided into two portions or regions, the subaerial and the subterranean. You will recognize the two partial environmental systems as *climatic* and *edaphic,* respectively, if you are familiar with recent ecological writing.

Commonly considered characteristics of the subaerial environment are: The chemical make-up of the air about our organisms (its content of oxygen, carbon dioxide, water vapor; sometimes of other gases); barometric pressure; air temperature; air movement; radiation (largely from sun and sky); evaporativity. Add to these: Precipitation (rain, dew, frost, snow, sleet, rime); the mechanical action of flood water, landslides and avalanches; dust fall; the incidence of organisms other than the ones specifically dealt with (air-borne seeds and spores, birds, insects and other animals and their products, including man with his tools). You thus have a representative though incomplete and altogether too general outline of the main things to be considered as comprising the subaerial environment. A similar superficial outline of subterranean conditions would include many of the properties of the soil solution and the wetness or dryness of the soil, the soil gases, barometric and hydrostatic pressure within the soil, movement of material and of organisms in the soil and soil temperature.

Like the vital complex, the environmental complex has many different dimensions, and our task is to learn just how the organism fits into its surroundings. We may be sure that the two complexes do fit very perfectly together; our main question is, what is the nature of the fit? This problem of physiological ecology would be difficult enough if the environmental features to be studied were always of the same nature and intensity, but they, as well as internal features, fluctuate continually; hence we are driven to study rates of change in the environment as well as in the organism and correspondingly our difficulties are enormously augmented.

It is sometimes advantageous to regard the environment as a dynamic system, which operates to supply material and energy to the organism, or to withhold them, and to remove material and energy from the organism. If environmental performance is not suited to the organism, the latter soon shows ill effects, as when the environment fails to supply water or suitable radiant energy at an adequate rate, or permits an excessive rate of water loss from the organism, or fails to remove carbon dioxide as rapidly as it is produced within the organism. The dynamic capacities of an environment to perform such requisite functions of supply and removal are in reality the very environmental characteristics whose quantitative estimate or measurement promises to be most valuable in our study of the interlocking controls by means of which the surroundings influence living things for good or ill. I have dwelt elsewhere on the concept of environments as operating systems and I need not attempt here the elucidation of that concept, but I may mention a few illustrations of dynamic environmental characteristics that have recently become measurable through newly developed methods of instrumental approach. (a) Evaporativity represents the power of the environment to remove water from an organism through evaporation, or to permit aqueous evaporation from plant and animal bodies by maintaining a low magnitude of external resistance to that process. (b) The dynamic capacity of the surroundings to supply radiant energy is a component of evaporativity, but of course it influences organisms in

other ways as well. (c) Oxygen-supplying power of the air about an organism is sometimes a limiting condition for health and development. (d) Similarly, the carbon-dioxide-supplying power of the adjacent air is of prime importance when green plants are being considered. (e) Finally, measurement of the water-supplying power, of the oxygen-supplying power and of the carbon-dioxide-supplying power of the soil furnishes indices that seem really to represent the fluctuating soil-moisture conditions and soil-air conditions as these are related to plants. The supplying power of an environment may, of course, be *negative* in some instances, as with regard to the removal of oxygen, carbon dioxide or water from the plant. Of course, a supplying power may be either too great or too small to suit the requirements of an organism, as has been indicated.

All the influential environmental characteristics, whether dynamic or static, not only differ from place to place in nature but generally fluctuate with time, and their respective magnitudes for any plant habitat require integration for specified time periods—such as weeks, months or seasons—before they may be used satisfactorily to enlarge our knowledge of concomitance between plant performance and environmental performance, in the study of environmental control of plant activity. Temperature summations for the growing season furnish a more or less familiar (but not very satisfactory) example of the integration of a fluctuating environmental characteristic. Daily, weekly or monthly totals of water loss from atmometers are automatic integrations of the fluctuating intensity of evaporativity.

When an environmental feature, such as temperature, for example, changes during a specified time period, it is not sufficient to know its mean or integrated value for that period, but we need to take account of the extreme values and the direction of change, whether upward or downward. To illustrate this point we may employ a very simple example, as follows: Consider three plants that are initially alike, suppose them to be exposed to favorable environmental complexes that are alike excepting for air temperature, and suppose that in an observation period the air temperature of one environment decreases uniformly from 30° to 10°, that in another environment this feature increases uniformly from 10° to 30° and that in the third environment air temperature is maintained at 20° throughout the period. Although the mean air temperature representing the observation period is obviously 20° in all three instances, yet the three plants would almost surely behave quite differently. The fundamental temperature relationship thus illustrated has thus far received almost no attention at all, but it is worthy of serious study in connection with the broader problem of environmental appraisal.

As long as we deal with natural conditions—as in most ecological, agricultural and silvicultural studies, and always to some extent when artificially controlled cultures are employed in adequately planned experimentation—an appraisal of environmental components and of environmental complexes must necessarily be based on suitable measurements and integrations. We attempt to depict the pattern of environmental performance in ways calculated to show how the surroundings act to control our organisms. Although available methods and procedures for such environmental appraisal are still crude and inadequate, yet I think enough has recently been accomplished in this connection to show the general direction in which future advance is to be made. We have already learned enough from more or less unsatisfactory efforts towards the evaluation of environmental influences to realize clearly the fundamental necessity for greatly improved methods of environmental instrumentation and for more suitable procedures in the logical analysis of our problems. For example, *depth* of rainfall is of little value in the appraisal of a climatic complex, and we shall have to turn to *duration* of rainfall (which is not yet seriously measured anywhere, I think) and to water-supplying power of the soil before we shall be able to go far in the study of the relations between plant health and precipitation. Again, we shall need to break our easy-going habit of considering air-moisture conditions in terms of the index of *relative humidity,* learning to employ in this connection such newer concepts as *water-saturation deficit* and *evaporativity.* Water content of the soil per unit of dry-soil weight is to be first replaced, in our ratiocination, by water content per unit of natural soil volume and the latter is to give way, in general, to water-supplying power. Similarly, oxygen content and carbon-dioxide content of the soil are to be replaced by oxygen-supplying power and carbon-dioxide-supplying power. Other similar needs will occur to you.

My fundamental proposition is simply that we need to study environments in terms of such environmental characteristics as promise to bring out the terms or components of environmental influence on organisms. The environmental features that we measure and integrate should be, as far as possible, just those features through which the organism is actually influenced. A homely example by analogy may illustrate this proposition: If one is about to erect a new garage for housing one's motor car one does not ordinarily consider the weight or the color or the horse-power of the car, but its length, breadth and height; nor does one primarily consider either floor

area or room volume with respect to the storage space required. The new structure would naturally be designed according to dimension features that are immediately applicable to the problem in hand.

In studies dealing with experiments in which some or many of the environmental components are artificially controlled, our problem is correspondingly less difficult, since artificially controlled conditions need not require measurement and in such experiments environmental fluctuation may be limited to certain previously planned patterns of relatively simple nature. Difficult as adequate artificial controls are, it is very much easier to set up and maintain artificial environments that perform in requisite ways than it is to find out by observation just how a natural environment performs. The growing of plants and animals under artificially controlled (and therefore fairly well understood) environments has recently made rapid headway, with the development of increasingly precise techniques for the maintenance of artificial conditions and for bringing a number of closely similar organisms under the influence of the same or different artificial environments at the same time.

Even in the most thoroughly planned experimentation, however, it is usually impossible to apply satisfactory artificial control to all influential features of the environment; comparative experiments generally involve some variables that are fairly well known, others that are known to some degree and still others that may be dealt with only in superficial ways. We naturally aim to bring as many as possible of our environmental variables into my first class.

An experiment carried out with suitable artificial control of the influential environmental features may usually be repeated almost at the will of the experimenter, as is generally true for the much simpler experiments of physical and chemical science. On the other hand, studies of natural environments are almost always impossible of satisfactory repetition, for nature repeats itself only approximately and one may have to wait a year or more for even the approximate recurrence of a set of natural conditions under which a first experiment was carried out.

The simplest problems of environmental relationships are naturally those that involve the fewest kinds of conditions. For this reason we are led, in our search for general or fundamental principles of environmental relations, to the experimental study of simple organisms (such as pure strains of bacteria, molds, seedlings, annuals—to illustrate by means of plant forms) in artificial environments that involve just as few influential features as possible. We sometimes encounter the mistaken notion that it is wellnigh a waste of time and effort to study the relations between simple life forms and artificial environments. I remember once recounting to an eminent chemist how we go to such great pains in conducting solution-culture experiments with ordinary plants. He pointed out that our experimental conditions are highly unnatural and that results obtained from them are not to be interpreted in terms of natural growth and development. It is of course true that the phenomena of highly complex natural systems can not be understood immediately or directly from the results of experimentation with much simpler, artificially controlled systems, but the surprising thing to me was that my eminent friend appeared to imply that our experiments were consequently hardly worth while at all. I still think my retort was passably good; I asked him how far he supposed theoretical chemistry might have progressed if chemists had always insisted on working only under natural conditions—without distilled water, without artificially purified compounds, without controlled temperature? We do hope that the basic principles derived from artificially and (in my present sense) adequately controlled experimentation may be helpful eventually in the study of natural conditions and in the field of applied science; but that hope must generally be a distant one and expectation must fall far short of our ideals. Experimentation directed specifically toward the improvement of biological applications usually needs to be planned and conducted *ad hoc,* with background complexes and experimental variables that in great measure resemble those that usually prevail in the applications considered. Such environments are, as a rule, much more complex than the relatively simple ones of adequately planned experimentation for the advanced theoretical sciences, and they are correspondingly less suitable for the elucidation of fundamental relations. Theoretical considerations usually demand a different sort of approach, after some pioneering has been accomplished—an approach that involves much more arduous planning and much more rigorous technique than are demanded by most practical tests. The foundation of science, as such, lies in this, I suppose, that relatively deep understanding and broad appreciation are pleasant and desirable things in themselves. We surely do not need to point to possible or conceivable practical applications to justify the finer and more elaborate kind of biological study, which is carried on primarily for the elucidation of basic principles.

We are coming increasingly to realize that the reactions of an organism to any single environmental influence are themselves conditioned by the whole complex of other concomitant influences. For example, in recent experimentation on young wheat seedlings grown in darkness, it was found that the presence of a specified and maintained concentrati

of ethylene in an otherwise specified, artificially maintained and generally favorable environmental complex exerted a notable influence on the rate of carbon-dioxide elimination, but this was true only when the maintained environmental oxygen pressure lay within restricted ranges of magnitude. With some ranges of oxygen pressure the presence of ethylene exerted no significant influence on carbon-dioxide output. But with some other ranges of oxygen pressure the ethylene effect was to *retard* that process, and with still other ranges of oxygen pressure the ethylene effect was an *acceleration*. The influence of this ethylene treatment on carbon-dioxide production was, therefore, either positive, zero or negative according to current oxygen pressure. Furthermore, both ethylene acceleration and ethylene retardation of carbon-dioxide production varied in magnitude in specific ways according to current oxygen pressure. With such observations in mind, we realize that oxygen pressure, as well as temperature, salt nutrition, water supply, and so on, must all be quantitatively specified before the nature and magnitude of the influence exerted by this particular ethylene treatment could be seriously studied. Numerous other examples of multiple environmental influences might be mentioned and I think no one now hesitates to accept this general principle. Our most serious need is, as I see things in the present connection, to learn how to take more and more environmental conditions into quantitative account at the same time. It is obviously desirable that we apply artificial controls as far as possible and that we employ enough suitable chosen intensities of one or more environmental features to represent a wide range of possibilities; but it is just as desirable that we describe the remaining conditions with sufficient precision to furnish a background basis or frame of reference, to which our results may be related.

It follows that the results of experimentation are to be considered only with specific reference to the background environmental complexes that prevailed in the experiments dealt with; I mean with reference to all the effective or influential environmental features that were not specified and treated as experimental variables. Otherwise, generalization tends to go too far and too fast. Most biological writers, including myself, are apt to be over-negligent of this principle, although it is likely that all of us would subscribe to it in a general way. For example, the statements just made concerning the apparent oxygen-pressure relations of the influence of our specified ethylene treatment on carbon-dioxide elimination from our young wheat seedlings, were purposely made in the past tense and with limiting phrases that naturally seem somewhat awkward. We can not logically use the present tense of generalization nor can we omit those awkward phrases, no matter what any editor may wish to do in the interest of smaller printing cost. We really know only that those results were obtained from series of tests of specified type, in which a number of different maintained oxygen pressures and one maintained ethylene pressure were employed, along with a number of different maintained temperatures and a specified set of background conditions. It naturally remains an open question whether results similar to those described might be secured with the same experimental variables but with a different environmental background.

It is my hope that these somewhat disconnected paragraphs of mine may have served to bring together in your minds some of the most obvious and pressing needs that characterize our present outlook over the physiological and ecological field of environmental relations. We should not be discouraged by the extent and complexity of that field. Let us not admit the barren thought that environments are hopelessly complex; after all, they are less complex than are the organisms that we study. Let us avoid that kind of scientific hopelessness that would postulate environmental influences that are fundamentally and eternally beyond the reach of patient exploration and inquiry. If some biology students have sometimes seemed to feel or believe that we are approaching the end of our capacity for appreciating the natural control of performance through understandable influences, I am inclined to think that no one has really come to such a view by rational mental endeavor. However that may be, there is surely no reason to think, even for a moment, that the field of environmental influences fails to offer still a very broad range of things that may be profitably studied by experiment, instrumentation and clear ratiocination.

Because organism and environment must be studied together if we hope to increase our understanding of the former, and because both of them are clearly very complex in their modes of activity and with regard to their conditional inter-relations, it naturally follows that our problems now require, more than ever before, cooperative efforts of several or many minds. At any rate, knowledge of many different kinds and constructive thought based on many different view-points will be required for further advance in such studies as we have been considering this evening. As I am sure we all realize, productive cooperative effort, even among devotees of science, is in itself a difficult thing to accomplish; it needs to be based to a considerable degree on mutual understanding among the cooperators and to a much greater degree on mutual appreciation. Understanding and appreciation among us has been facilitated and encouraged by the American

Society of Naturalists, largely through its meetings and symposia, but partly through the intangible but quite significant *esprit de corps* that has so happily prevailed among our numbers. To aid in bringing all kinds of biologists together may well be the main aim of this society.

LOCAL BRANCHES OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

By J. McKEEN CATTELL

AT the meeting of the executive committee of the American Association held in New York on October 21, the question of the organization of local branches was considered and a committee to carry out the work was appointed consisting of Otis W. Caldwell, chairman; J. McKeen Cattell, chairman of the executive committee; Henry B. Ward, permanent secretary; Burton E. Livingston, general secretary, and Karl T. Compton. Members of this committee who could remain in New York the following day discussed the situation and an informal statement of plans proposed is here made in order that they may be brought to the attention of members of the association and secure their cooperation.

Local branches are authorized by the constitution drafted by the present writer in 1918 and adopted at the St. Louis meeting on January 3, 1920. Article 6 reads: "Regional Divisions and Local Branches of the association may be formed by vote of the Council. Such Divisions and Branches may elect officers, hold meetings, appoint committees, enter into relations with other societies, and promote within their fields the objects of the Association."

In accordance with the provisions of this article of the constitution there have been established the Pacific Division, organized in 1915, and the Southwestern Division, organized in 1920. An amendment to the constitution was later adopted providing for representation on the council of the affiliated state academies of science. Previously and since there have become affiliated with the association twenty-six state academies and two city academies. The work involved in the organization of the divisions and the affiliation of the academies has been large, and it is only within the last four years that the association has had other than a part-time secretary, whose time was fully occupied in the arrangements for the meetings and other pressing work of the association. The problem of the organization of branches has not as yet been taken up seriously, though two were established many years ago—one in Rochester and one in Pennsylvania State College.

Some thirty years ago a committee of the association on local branches was appointed, of which the late Dr. R. S. Woodward, then professor of Columbia University and later president of the Carnegie Institution of Washington, and the present writer were the active members. A certain amount of work was done at that time, but it could not be taken up by the central office, for the secretary then was receiving a salary of only $1,500, and, in addition to his official work as head of the Bureau of Entomology, was carrying on research work of importance.

With a membership so large and so widely scattered over the continent it is almost essential to have local and divisional organization. The American Association has its two western divisions and its affiliated academies; it would probably be advantageous to form other divisions covering the United States and Canada. It is the problem of local branches that is of present concern, but these may become the units in a state organization, perhaps under the auspices of the State Academies of Science.

Other professional societies have a more adequate organization than the American Association. For example, the American Medical Association is organized by counties and states; no physician can be a member of the national organization unless he is a member of the state society or of the state society unless he is a member of the county society. The regional divisions of the American Chemical Society cover the country. There are educational associations in every state.

Even without a satisfactory organization the American Association has advanced greatly during the past thirty years in membership and influence. In addition to the affiliated academies there are some 140 associated societies, and the membership had increased in 1931 to nearly 20,000. The comparatively small decrease in 1932 and 1933 has been followed by a moderate gain in 1934, the total membership now being about 18,000. A membership of 20,000 should be reached within the next year or two.

The membership can be increased by the organization of local branches; but the primary object of their organization is to forward in all localities the objects of the association which, according to the first article of the constitution, are: "To promote intercourse among those who are cultivating science in different parts of America, to cooperate with other scientific

societies and institutions, to give a stronger and more general impulse and more systematic direction to scientific research, and to procure for the labors of scientific men increased facilities and a wider usefulness."

The excellent geographical index of members of the association, published in the volume of summarized proceedings recently issued, emphasizes the large membership and its wide distribution. For example, in the State of Pennsylvania the distribution of the members in places where there are five or more is as follows:

Philadelphia—(Univ. of Pa. and others)	413
Pittsburgh—(Univ. of Pittsburgh and others)	251
State College—(Pennsylvania State College)	86
Bethlehem—(Lehigh; Moravian Coll.)	36
Swarthmore—(Swarthmore)	28
Easton—(Lafayette)	21
Harrisburg	20
Lancaster—(Franklin and Marshall)	20
Bryn Mawr—(Bryn Mawr)	16
Erie	13
Haverford—(Haverford)	12
Lewisburg—(Bucknell)	11
Allentown—(Cedar Crest)	10
Reading	9
Upper Darby	9
Carlisle—(Dickinson)	8
Scranton—(Marywood; St. Thomas)	8
West Chester	8
Lansdowne	7
Washington—(Washington and Jefferson)	7
Chambersburg—(Wilson)	6
Drexel Hill	6
Gettysburg—(Gettysburg)	6
York	6
Annville—(Lebanon Valley)	5
Jenkintown—(Beaver)	5
Johnstown	5
New Wilmington—(Westminster)	5
Ridley Park	5

These data for Pennsylvania are given because in the organization of local branches it would be desirable to give special attention to centers near the place of the annual meeting, in order to increase interest in that meeting, and because it would bring the association to the attention of the scientific men of the region. Consequently towns in Pennsylvania and Ohio, together with the adjacent parts of New York and West Virginia, should now be specially considered. It may not be useful for the present to attempt to organize a local branch in Philadelphia, for in that city there are many organizations and opportunities for scientific meetings. The same situation holds for Pittsburgh, but it might be well to consider the questions involved in the establishment of a branch there at the time of the approaching meeting. The places where local branches would probably be most useful and successful are the college towns, as indicated in the list given above, such as Bethlehem, where there are 36 members; Easton, where there are 21 members; and Lancaster, where there are 20 members.

It is proposed that the local branches shall have complete autonomy in their communities. They will only be established where the resident members of the association think that it would be desirable to form a scientific center. These members would serve as a center of organization and would doubtless wish to interest in the branch other scientific men not members of the association but eligible to fellowship, and those engaged in professions and business having intellectual interests and eligible to membership. It is not intended that any pressure shall be brought on those cooperating in a local branch to join the association. It may, however, be desirable to have in a branch two classes of members—those who at the time of organization are members of the association, and those who would join in the work and who might be designated as associates of the branch. The question of finances would be settled by each branch; there might be no dues and no regular expenses, or there might be an annual fee, say of one dollar, that could be used to promote the objects of the branch. Lectures and other programs could be arranged to which admission would be charged.

The branches might be expected to seek the cooperation of other organizations in the locality. Science within recent years has been acknowledged to be through its applications the basis of our civilization. If there had been no development of methods to increase wealth there could be no universal education, no prohibition of child labor, no freedom for women, no democracy. The situation has in recent years—thanks in large measure to the organization of Science Service—become rapidly recognized by the press, which gives increasing attention to science, and to a lesser though not insignificant extent by the radio and the movie.

The local branches would presumably aim to interest in science other organizations, such as the Rotary and Kiwanis Clubs and the corresponding clubs for women. An especially promising field appears to be country and golf clubs. They have definite and useful functions in their golf, tennis and the rest, and in the social relations that are formed and promoted. Science is doubtless often the subject of conversation, but some scientific interests might be taken up as hobbies, for every science has aspects of interest to those who are members of golf and country clubs. Beginning with astronomy and extending to psychology there are portions of each science that can be

cultivated to advantage in the leisure time likely to precede or follow golf or tennis, which indeed on wet days may occupy the whole time.

If we begin with mathematics, the queen who rules over the exact sciences, and pass over compound interest and minus quantities in the red to the theory of probabilities, it may be noted that knowledge here is essential to the most expert poker and bridge playing. On an Atlantic trip the writer once plotted on a curve bids on the daily mileage and was in a position to make a bid with odds in his favor. By sheer luck he won the pool three days out of five and attained reputation as a great psychologist. In astronomy it may be noted that a large part of the observations made on falling stars and the like are reported from gulf clubs; that a telescope and other astronomical instruments could be acquired to advantage. In physics any golf or baseball player would be interested in an article printed some years ago in *The Scientific Monthly* on the course of a golf ball by the greatest living physicist, Sir Joseph Thomson. Meteorology is a branch of physics; the weather—especially on the golf links—must become again the chief topic for casual conversation, now that prohibition is out of the way. Chemistry appeals to a very wide range of human interests. As a minor example, cooking, distilling and fermentation are applied chemical sciences. Geology and geography are obviously concerned with the golf course and its hazards.

Zoology also applies directly to the situation. A bulletin board recording the date and observer of the first and last appearances of birds and insects would attract general attention. The cause of the prevalence of mosquitoes and flies is of direct interest. In botany we have not only the greens and lawns, but it would be easy to make a botanical garden about a golf course that would add much to its attractions. Physiology, anatomy and all the medical sciences can be applied, not only to what the player should or should not do, but also to how to do it properly. Psychology, concerned with behavior and social intercourse, is of interest to all, but it has aspects of special concern to those engaged in competitive sports or having leisure to discuss things in general.

It is quite possible that an impulse toward greater interest in science might be given by organizing under the auspices of country and other clubs special groups, with talks and discussions that would be of interest and might be useful in attracting new members. Adult education of itself as a formal discipline has drawbacks, but certainly any movement that will interest people in science, and the association of science with avocations and recreations such as golf and bridge, deserves encouragement.

People in the large centers perhaps have as many formal lectures as they need, though they are still interested in good lectures. For example, at a meeting in November of the National Academy of Sciences at Cleveland, a $3,000,000 music hall was filled with an audience of 1,600 to listen to a lecture by Dr. Harlow Shapley. He is doubtless the star lecturer of the academy, and, as the president said in introducing him, his work covers a wide field. If the present writer had given the lecture on relations of time and space in vision the audience might have been reduced by 90 per cent. It is obvious that Dr. Shapley could not lecture under the auspices of many local branches, but he might very well give in Boston a lecture, sent all over the country by short wave transmission, of which branches could be informed and to which members might listen in; or his slides and mimeographed notes could be supplied to a local scientific man, who, with proper credit, could base on them a most interesting lecture. Besides there are many scientific men who can talk well if given a chance. The writer once compiled a list of over a hundred psychologists competent and willing to lecture for a fee varying from $200 to $0. It is, however, to be assumed that local branches would get on best in less formal meetings, such as luncheons or dinners, at which a local scientific man, or one from a distance, might talk in a more or less informal way and be followed by still more informal discussion.

The advantages of organization through the American Association or the State Academies of Science are that it would give opportunity for cooperation. Neighboring branches might meet together. The writer, for example, once addressed at Bethlehem a joint meeting of the professors of Lehigh University and Lafayette College. Through such meetings and various forms of cooperation each branch might find out what other branches were doing and could take up the interests that were most successful. Each may learn by the trial and success method what can be done to best advantage to advance the interests of science. Those that succeed can act as missionaries to teach their methods to other communities; those that fail can remain inactive until there is a more favorable opportunity to take up the work.

The subject of promoting interest in science through local branches under the auspices of the American Association for the Advancement of Science is so large that this communication must be terminated with many things left unsaid. It represents only the point of view of the writer. An official report on the subject will be presented at the Pittsburgh meeting of the association.[1]

[1] Those members who are interested in local branches can communicate with the chairman of the newly appointed Committee on Organization, Dr. Otis W. Caldwell, 433 West 123rd Street, New York City.

OBITUARY

THEOBALD SMITH[1]

WE are here to pay homage and respect to a noble personality, Theobald Smith, whose life was spent in intimate association with us. We are here with a sense of deep satisfaction for having known him. We are here with an unavoidable emotion of pride in counting ourselves among his friends. We are here with a sense of actual joy at the realization that a leader among us could have so beautifully and completely rounded out a life of perfect accomplishments as an example and inspiration to each of us.

Dr. Theobald Smith began his scientific life, and continued it, as a simple unassuming student of nature. He was in the highest sense a naturalist. He was devoted to simple understanding and constructive thinking. Complexities and uncertainties were realities to him, but his mind made no attempt to encompass complexities. The direction of his thought was toward finding some means of reduction to elementary simplicity.

He said on the opening of this house: "We who have dealt with the finitely small living things have perhaps as much a sense of the highly complex, unfathomable, the eternally elusive in the universe as do those who look for the outer boundaries of space. Each group contributes a different story of the same final significance."

He was clear-minded, strict-minded and absolutely honest. He was tolerant where tolerance is a virtue, but was emphatically intolerant of any compromise with error. He avoided every semblance of deceit, he was unpretentious and was most careful not to deceive himself. While in a world of cloudy and confused thinking with bungling attempts at the solution of pressing problems it is a joy and inspiration to have known a mind of such direction and clearness as that of Theobald Smith.

Dr. Smith's genius displayed to a high degree the rare quality of foresight. He visualized the line of attack on a broad problem as the master artist in his imagination sees the finished creation before it is begun. He carefully proceeded along the line of his interest step by step with a seeing eye and a penetrating appreciation of the meaning in what he saw. To him the greatest reward was the solution of the problem and toward this his efforts were ever turned.

He was the originator and the builder of the opportunities and the fields in which he worked. When a young man of twenty-five, and only one year after his graduation from medical college, he joined the service of his country in its battle against animal disease. His intelligence and keen foresight made him aware of the problems of this undertaking in a way that others had not comprehended. Very soon he had accomplished the fundamental discovery of the rôle of the intermediate host in parasitic and infectious diseases. This knowledge is to-day one of the most fundamental possessions of preventive medicine in maintaining the public's health.

Dr. Smith's work in the Bureau of Animal Industry was of such significance that after only a few years he was invited to a great university as professor of applied zoology. This call was not to fill an already existing chair. Such a professorship had never existed anywhere before. It was created for and by Dr. Smith in order to give place to the new field in medical science which he had discovered. This chair after one year was transferred to the medical faculty and the designation of Dr. Smith's position was changed to that of professor of comparative pathology.

At Harvard University Dr. Smith built this new department into one of great strength and importance so that it became an example to other universities of the country, which to this day have been unable to imitate it for want of men with the scientific outlook such as he had. The department of comparative pathology at Harvard was Dr. Smith's second large creation—but his imagination and foresight made him willing to leave it.

On the occasion of his departure from Harvard Ex-President Eliot paid him the following tribute: "I have felt under great obligations to Dr. Smith ever since I first made his acquaintance twenty years ago. He has stood for me ever since as completely satisfying my ideal of the type of modern scientist—simple, diligent, loving truth, seeking truth, but seeking it for the promotion of the welfare of mankind."

Twenty years ago Dr. Smith came to the Rockefeller Institute as director of the department of animal pathology. Such a department did not exist at the time, and again Dr. Smith was to create it as well as to direct its growth and development. Here Theobald Smith, at the age of fifty-five, began anew, and with the same forethought and vision, but with greater opportunity, developed an institute which, in its organization and facilities for the study of the biology of disease, is an outstanding model for the entire world. No one here will misunderstand what I have said as intimating that Dr. Smith was concerned with material building. The architectural designs to which I refer are far rarer and more subtle in nature than those built of stone alone. His building was the creation and construction of arrangements which

[1] An appreciation of Dr. Smith given at his funeral in "The Theobald Smith House" of the Rockefeller Institute for Medical Research at Princeton, New Jersey, on December 13, 1934.

would facilitate a freer, deeper and broader attack on the problems of biologic associations and animal disease than were possible before he built.

Theobald Smith was one of nature's high priests. He believed with Pasteur that science, in obeying the law of humanity, will always labor to enlarge the frontiers of life; and with Goethe, that the first and last thing required of genius is the love of truth.

He built temples to nature and communed in them by whispering questions to her. And nature answered back to this favored son—and he understood.

CHARLES R. STOCKARD

RECENT DEATHS

DR. WILLIAM HUBERT BURR, consulting engineer, professor of civil engineering at Columbia University from 1893 until his retirement in 1916 with the title emeritus, died on December 13. He was eighty-three years old.

DR. CHARLES FERGUS BINNS, director emeritus of the New York State College of Ceramics at Alfred University, died on December 4 at the age of seventy-seven years.

DR. FRANK CARNEY, professor of geology and geography at Baylor University, Waco, Tex., died on December 13. He was sixty-six years old.

DR. ALLAN WINTER ROWE, director of research at Evans Memorial Hospital, Boston, formerly president of the Boston School of Physical Education, died on December 6 at the age of fifty-five years.

DRS. JOHN W. CARMACK and Arthur M. Mendenhall, professor of rhinology, otology and laryngology and professor of obstetrics, respectively, at the Indiana University School of Medicine, were killed in an airplane accident on December 5. A memorial meeting was held by the Indianapolis Medical Society on December 7.

ADRIEN DE GERLACHE, Belgium, Arctic and Antarctic explorer, died on December 4. He was sixty-eight years old.

SCIENTIFIC EVENTS

BIRD SANCTUARY IN NEW YORK CITY

NINE acres of natural woodland on the Bronx River, between the new Thompson Memorial Rock Garden and the large iris plantation in the New York Botanical Garden, early next spring are to be enclosed by a fence, within which birds may find shelter unmolested and wild flowers and trees of New York will be planted and protected. Birds are to be encouraged to stay over winter by being fed. Entrance to this sanctuary will be permitted only to those whose honorable interest in wild life is assured.

The idea of the sanctuary within the city limits, where birds and wild flowers are particularly precious, was inspired by the sanctuary created by Mrs. James Baird on the grounds of the Scarsdale Golf Club. This area, established only five years ago, when the club threatened to cut down a magnificent stretch of natural woods, has already become a haven for many birds, who naturally appreciate this bit of forest preserved for them. The existing growth of the area has been augmented by the planting of some of the finest of the native shrubs and flowers.

The New York Bird and Tree Club, which is now sending out pleas for new memberships and for additional funds to help in constructing the fence which will mean the establishment of the new sanctuary, hopes to make this project as outstanding a piece of work as it did when it raised $12,000 a number of years ago for the replanting of orchards which had been devastated by the war in France.

The sanctuary at the Botanical Garden is to be made a memorial to Mrs. Nathaniel Lord Britton, wife of the founder and former director of the institution and herself an ardent worker for the preservation of wild life. It has been suggested that sections of the fence be dedicated as memorials to others. Mrs. William Wallace Nichols, of Scarsdale, is chairman of the sanctuary.

Eventually, the club aims to establish arboretums in other states, beginning with New Jersey, where Mrs. Thomas A. Edison is to be the chairman. But the immediate endeavor of the 200 members is to raise funds for the New York City sanctuary at The New York Botanical Garden in Bronx Park. The garden itself is offering all possible support and cooperation for this project.

E. D. MERRILL,
Director

ORNITHOLOGICAL EXPEDITION FROM CORNELL UNIVERSITY

PROFESSOR ARTHUR A. ALLEN, of the Laboratory of Ornithology at Cornell University, will lead an expedition next spring to search out the haunts of rare North American birds in order to preserve for future generations their habits and calls. A. R. Brand, formerly of the American Museum of Natural History, now an associate in ornithology at Cornell, is sponsoring the expedition. P. P. Kellogg, instructor in ornithology, and Dr. George M. Sutton, curator of birds, will make up the rest of the party, which will start in two trucks for the South and West at the end of Feb-

ruary. The trucks will be equipped with cameras and blinds and modern sound-recording equipment so that the voices as well as the actions and appearance of the bird can be recorded on films and preserved for posterity.

Birds that will be studied on this expedition include the ivory-billed woodpecker, the sandhill crane, the limpkin or crying bird, the trumpeter swan, the lesser prairie chicken, the golden eagle and perhaps the whooping crane, rarest of all North American birds and also the largest.

No attempt will be made to collect or disturb in any way these rare species, while every effort and all modern equipment will be utilized in order to bring back permanent records on films of their environment, their habits, their songs, their calls and their companions, so that a habitat group can be set up in the Cornell Museum.

A. R. Brand and P. P. Kellogg are experts in sound recording, and Mr. Brand has recently published a book of bird songs illustrated with phonograph records taken from his films of birds singing in their natural habitats. Professor Allen is known not only for his research studies of birds and game and his popular bird books, but as a camera expert. George Sutton, author and explorer, and one of the leading bird artists of the country, on this expedition will make color sketches of birds from life, so that such evanescent characteristics as color of eyes and bills, which fades soon after death, will be more accurately preserved than has been hitherto possible.

The exact route of the expedition has not yet been worked out in detail, but it is expected that the start will be made in Florida and Louisiana, from which the most recent reports of ivory-billed woodpeckers have come—thence to Texas, Oklahoma, Colorado and Wyoming.

Efforts will be made to record not only the voices of the rarest birds, but also those of the commonest songsters. This has never been done, and Mr. Brand is anxious to get them all transferred to phonograph records, where they will be available to any one interested, and will be valuable adjuncts to all natural history teaching.

EXHIBITION AND PUBLICATIONS AT THE CARNEGIE INSTITUTION OF WASHINGTON

AN exhibition representing results of the research activities of the Carnegie Institution of Washington was held on December 14, 15, 16 and 17. A list of these exhibits is given below.

The Physical Basis of Heredity:

a. The relation between characters, genes and chromosomes: Dr. T. H. Morgan, research associate, and Dr. C. B. Bridges.

b. The nature of the gene: Department of Genetics.

c. Chromosome structure and chromosome behavior during the development of the embryo: Department of Embryology.

Developmental Changes within a Single Hereditary Pattern: Dr. Hugh H. Darby.

Improved Embryological Methods: Department of Embryology.

The Significance of Leaf Pigments: Division of Plant Biology.

A Simplified Respiration Apparatus for the Rapid Determination of Human Basal Metabolism: Nutrition Laboratory.

Explorations in Middle America:

a. Pottery from Guatemala.

b. The Maya altar from Quirigua.

c. Newly discovered cities in Campeche.

Division of Historical Research.

Daily Changes in the Compass Direction: Department of Terrestrial Magnetism.

The Distances of the Stars:

a. Direct measurement of distance.

b. Spectroscopic method.

c. Stellar systems and receding nebulae.

Mount Wilson Observatory.

The Silicates of Ferrous Iron: Geophysical Laboratory.

Publications

In addition to the exhibits a program of public lectures was given by members of the institute. These were:

December 15: "The Pigments of Leaves," H. A. Spoehr.

"The Silicates of Ferrous Iron," J. F. Schairer.

December 16: "The Physical Basis of Heredity," C. B. Bridges.

"A Simplified Respiration Apparatus for the Rapid Determination of Human Basal Metabolism," F. G. Benedict.

"Uaxactun, the Oldest Maya City," A. V. Kidder.

December 17: "The Distances of the Stars," R. F. Sanford.

"The Daily Changes in Compass Direction," A. G. McNish.

THE ANNUAL MEETING OF THE AMERICAN PHYSICAL SOCIETY AND THE SECTION OF PHYSICS

THE thirty-sixth annual meeting (the 196th regular meeting) of the American Physical Society will be held at Pittsburgh on December 27, 28 and 29, in affiliation with Section B—Physics—of the American Association for the Advancement of Science. The general business session will be at 2 o'clock on Thursday afternoon, December 27, at the Carnegie Institute of Technology, after which Professor R. W. Wood, vice-president of the society, will deliver an address on "Some Unusual Optical Problems."

Dr. Henry Norris Russell, research professor of astronomy at Princeton University, will deliver on December 31 his address as retiring president of the American Association, on "The Atmospheres of the Planets." Dr. C. J. Davisson, of the Bell Telephone Laboratories, will give the address of the retiring vice-president of Section B—Physics—of the American Association at the Carnegie Institute of Technology at the joint session with the American Physical Society on Thursday afternoon at 2:30 o'clock. The subject of his address will be "Electron Optics." The Willard Gibbs lecture will be given by Dr. Albert Einstein on December 28 at 4:30 o'clock.

On Friday morning from 10:00 to 12:30 o'clock and again on Friday afternoon from 2:00 to 4:00 o'clock there will be held a symposium of invited papers on "Heavy Hydrogen and its Compounds" as a joint session with the Section of Physics, the Section of Chemistry and the American Association of Physics Teachers. The speakers at the morning session for physics will be G. H. Dieke, of the Johns Hopkins University; R. C. Gibbs, of Cornell University; Otto Stern, of the Carnegie Institute of Technology, and M. A. Tuve, of the Department of Terrestrial Magnetism of the Carnegie Institution of Washington. At the afternoon session for chemistry the speakers will be John R. Bates, of Princeton University; F. G. Brickwedde, of the Bureau of Standards; Herrick L. Johnston, of the Ohio State University, and Hugh S. Taylor, of Princeton University. The presiding officers will be Karl K. Darrow, of the Bell Telephone Laboratories, for the physics session and Harold C. Urey, of Columbia University, for the chemistry session.

On Saturday afternoon, from 1:30 to 4:00 o'clock, there will be a joint symposium with the American Mathematical Society on "Group Theory as Applied to Quantum Mechanics." The speakers will be G. Breit, of the University of Wisconsin, John von Neumann, of the Institute for Advanced Study, J. H. Van Vleck, of Harvard University, and E. P. Wigner, of Princeton University. A joint session with the Acoustical Society of America also will be held at the University of Pittsburgh on Saturday afternoon from 2:00 to 4:30 o'clock.

The annual dinner will be held at the Webster Hall Hotel, headquarters for the society, on Friday evening at 7:00 o'clock. This will be a joint dinner with the American Association of Physics Teachers.

WORK OF THE SCIENCE ADVISORY BOARD

DR. KARL T. COMPTON, chairman of the Science Advisory Board and president of the Massachusetts Institute of Technology, has prepared for Science Service the following statement concerning the work of the Science Advisory Board.

The Science Advisory Board, appointed by President Roosevelt on July 31, 1933, represents a new form of cooperation of the nation's scientific personnel with the government in its varied scientific services. It supplements and cooperates with the National Academy of Sciences and the National Research Council, which were established during the national emergencies of the civil war and the great war, respectively, to aid the government, and which play an important rôle in the organization of the nation's scientific forces for increased effectiveness in ordinary times and particularly in times of stress.

The Science Advisory Board has submitted to the President of the United States a report on its work from the date of appointment to September 1, 1934. While the details of this report can only be made public subject to release by the President, there is no impropriety in disclosing the general scope of the subjects which have engaged the study of the board and its committees. Important among these subjects have been the program of the U. S. Weather Bureau, with particular reference to methods of weather forecasting and the cooperation of other governmental services; cooperation with a committee of railroad presidents to determine fundamental aspects of policy and organization, for insuring to the railroads the best contributions from modern science; questions of organization and program in the U. S. Geological Survey and the U. S. Bureau of Mines, with particular reference to the need for more adequate handling of mineral statistical information; redefinition of the functions of the U. S. Bureau of Standards, with detailed consideration of its program and needs and particularly its method of cooperation with industry in the establishment of trade and commercial standards; a study of the surveying and mapping activities of the government distributed through 28 government bureaus, with particular consideration of efficiency in mapping and efficient service of mapping agencies to organizations which need maps for their operations; the formulation of a scientific basis for studies and administration of problems of land use, including soil erosion; preliminary studies of the chemical services of the government and also of certain features of a program for stimulation of new and preferably non-competitive industries.

In handling each of these and similar problems, the board has established committees of prominent scientists and administrators who are preeminently competent in their respective fields, and including on each committee one or more members of the board. These committees have carried on the detailed studies and formulated recommendations which have then been presented to the board, forming the basis of the board's reports to the department secretaries or other

administrative officers of the government. This procedure has worked effectively and rapidly, and the response of leading scientists and engineers to requests by the board for their services on these committees has been uniformly gratifying and has demonstrated the eagerness and effectiveness with which such men are willing to devote their time and energy to government service for the sake of the most efficient operation of the government services which relate to their particular fields of interest. These committees, as well as the members of the board, have served entirely without compensation.

The Science Advisory Board was appointed by the President "with authority, acting through the machinery and under the jurisdiction of the National Academy of Sciences and the National Research Council, to appoint committees to deal with specific problems in the various departments." This board consists of the following members:

Karl T. Compton, chairman, president of the Massachusetts Institute of Technology.

W. W. Campbell, president of the National Academy of Sciences.

Isaiah Bowman, chairman of the National Research Council; director of the American Geographical Society.

Gano Dunn, president of the J. G. White Engineering Corporation.

Frank B. Jewett, vice-president of the American Telephone and Telegraph Company; president of the Bell Telephone Laboratories, Inc.

Charles F. Kettering, vice-president of the General Motors Corporation; president of the General Motors Research Corporation.

C. K. Leith, professor of geology at the University of Wisconsin.

John C. Merriam, president of the Carnegie Institution of Washington.

R. A. Millikan, director of the Norman Bridge Laboratory of Physics and chairman of the executive council, California Institute of Technology.

Roger Adams, professor of organic chemistry and chairman of the department of chemistry at the University of Illinois (president-elect of the American Chemical Society).

Simon Flexner, director of the laboratories of the Rockefeller Institute for Medical Research, New York City.

Lewis R. Jones, professor of plant pathology at the University of Wisconsin.

Frank R. Lillie, Andrew MacLeish distinguished service professor of zoology and embryology and dean of the division of the biological sciences, University of Chicago.

Milton J. Rosenau, Charles White professor of preventive medicine and hygiene at the Harvard Medical School and professor of epidemiology at the Harvard School of Public Health.

Thomas Parran, Jr., state commissioner of health for New York.

SCIENTIFIC NOTES AND NEWS

AN extended article concerning the Pittsburgh meeting of the American Association for the Advancement of Science, which opens on December 27, prepared by Dr. Henry B. Ward, permanent secretary of the association, will be found in the issue of SCIENCE for November 30. Dr. Edward L. Thorndike, professor of educational psychology at Teachers College, Columbia University, presides, and the address of the retiring president will be made by Professor Henry Norris Russell, research professor of astronomy at Princeton University, on "The Atmospheres of the Planets." There have been arranged for the meeting many addresses of more than ordinary interest, including one by Professor Albert Einstein. Pittsburgh is not far from the center of scientific population of the country and a large attendance and a successful meeting are assured.

SECTIONAL presidents of the British Association for the Advancement of Science have been appointed as follows: Mathematical and Physical Sciences, Dr. F. W. Aston; Chemistry, Professor W. N. Haworth; Geology, Professor G. Hickling; Zoology, Professor F. Balfour Browne; Geography, Professor F. Debenham; Economic Science and Statistics, Professor J. G. Smith; Engineering, J. S. Wilson; Anthropology, Dr. Cyril Fox; Physiology, Professor P. T. Herring; Psychology, Dr. Ll. Wynn Jones; Botany, F. T. Brooks; Educational Science, Dr. A. W. Pickard-Cambridge; Agriculture, Dr. J. A. Venn. The annual meeting will be held next year in Norwich from September 4 to 11, under the presidency of Professor W. W. Watts, emeritus professor of geology in the Imperial College of Science and Technology, South Kensington.

THE Chandler Medal for 1934 for "conspicuous work in the field of chemistry" was conferred by Columbia University on December 14 on Dr. Jacob Goodale Lipman, dean of agriculture in Rutgers University and director of the New Jersey Agricultural Experiment Station, for "his outstanding achievements in the field of agricultural chemistry." Dean Howard Lee McBain, of the graduate faculties of Columbia University, made the presentation before nearly four hundred scientific men. Mrs. Charles F. Chandler was present.

DR. OTIS W. CALDWELL, professor of education and director of the Institute of School Experimentation

at Teachers College, Columbia University, has been elected the first honorary member of the Central Association of Science and Mathematics Teachers. The announcement was made at the recent annual dinner, at which he was toastmaster. Dr. Caldwell is one of the founders of the association and is the oldest living past-president.

DR. MARION, professor of urology in the faculty of medicine of the University of Paris, has been elected a member of the Paris Academy of Medicine in the section of surgery.

UNIVERSITY COLLEGE, London, was recently presented with a portrait of Sir Flinders Petrie, emeritus professor of Egyptology. The portrait was subscribed for and presented by over three hundred of his friends. It is the work of Mr. P. de Laszlo. Colonel Sir Henry Lyons made the presentation on behalf of the subscribers, and Sir John Rose Bradford, chairman of University College Committee, accepted the portrait on behalf of the college.

THE Petrie Medal for distinguished work in archeology of the University of London has been awarded, according to *Nature,* to the Abbé Henri Breuil, professor of prehistoric ethnography at the Institute of Human Paleontology and of prehistory at the Collège de France.

DR. R. E. ROSE, director of the technical laboratory of the Organic Chemicals Department of the E. I. du Pont de Nemours and Company, Inc., presided at the annual convention of the American Association of Textile Chemists and Colorists, at which more than five hundred and fifty delegates were present. Dr. Rose was reelected president for the coming year.

AT the annual meeting of the American Society of Agronomy, held in Washington on November 22 and 23, the following officers were elected: Dr. H. K. Hayes, University of Minnesota, St. Paul, *president;* Professor R. M. Salter, Agricultural Experiment Station, Wooster, Ohio, *vice-president;* Professor J. D. Luckett, Agricultural Experiment Station, Geneva, N. Y., *editor;* Dr. C. E. Millar, State College, East Lansing, Mich., *chairman,* Soils Section; Professor R. D. Lewis, Ohio State University, *chairman,* Crops Section; Dr. P. E. Brown, Iowa State College, *secretary-treasurer;* Dr. W. A. Albrecht, University of Missouri, and Dr. T. A. Kiesselbach, University of Nebraska, representatives on the council of the American Association for the Advancement of Science. Fellows of the society were elected as follows: Dr. John H. Parker, of Kansas; Dr. F. D. Richey, of the Bureau of Plant Industry, and Dr. R. M. Salter, of the Ohio State University.

Nature reports that officers of the Cambridge Philosophical Society for 1934–35 have been elected as follows: *President,* Professor J. Barcroft; *Vice-presidents,* Professors E. K. Rideal, A. Hutchinson and E. D. Adrian; *Treasurer,* F. A. Potts; *Secretaries,* F. P. White, Dr. J. D. Cockcroft, Dr. H. H. Thomas; *New Members of Council,* Professor G. H. Hardy, Dr. E. G. Holmes and Dr. M. Born.

PROFESSOR K. WENCKEBACH, of Vienna, has been appointed honorary president and Professor W. Kuenen, of Leiden, president, of the recently founded Dutch Association for Cardiology.

THE board of trustees of Rensselaer Polytechnic Institute have elected Edwin S. Jarrett, consulting engineer of New York City, vice-president of the institute, with the duties and powers of the president, to act as head until the appointment of a successor to Dr. Palmer Chamberlaine Ricketts, president and director, who died on December 10.

AT the University of Nebraska Professor W. C. Brenke has been made chairman of the department of mathematics. The retiring chairman, Professor A. L. Candy, will continue to teach in the department.

DR. THOMAS HORACE EVANS, formerly associate professor of anatomy at the Long Island College of Medicine, has been elected by the Board of Trustees of the New York Homeopathic Medical College and Flower Hospital as research professor of anatomy.

DR. EDWARD SAMPSON, associate professor of geology at Princeton University, has been appointed departmental chairman.

DR. LEON CARDENAL, professor of surgery at Madrid and president of the last International Congress on Cancer, has been nominated rector of the University of Madrid.

DR. MARTHA M. ELIOT, formerly associate clinical professor of pediatrics at Yale University School of Medicine and for several years director of the division of maternal and child health in the Children's Bureau of the U. S. Department of Labor, has been appointed assistant chief of the bureau. She will have charge of all matters relating to health. Miss Eliot has been on the staff of the Children's Bureau since 1904.

THE editorial board of *Genetics* has added the following members: Dr. L. J. Cole, University of Wisconsin; Dr. L. C. Dunn, Columbia University; Dr. J. W. Gowen, Rockefeller Institute for Medical Research; Dr. A. H. Sturtevant, the California Institute of Technology, and Dr. Sewall Wright, the University of Chicago.

PROFESSOR FERNAND BEZANÇON has been nominated general secretary of the International Union against Tuberculosis, in the place of the late Professor Léon Bernard.

DR. W. TAYLOR THOM, JR., associate professor of geology at Princeton University, has become special assistant to the Subsistence Homestead Division of the Department of the Interior, contributing his services as director of a survey of the coal-mining industry.

DR. R. W. CILENTO, formerly director of public health in New Guinea and of the Australian Institute of Tropical Medicine at Townsville, subsequently the director of the division of tropical hygiene, has been appointed director general of health and medical services in Queensland. He will be given control not only of the hospitals and medical services, aborigines; insanity and aged people's homes, but also of health services now covered by other departments.

DR. OTIS C. TRIMBLE, associate professor of psychology at Purdue University, has been allowed a grant-in-aid by the National Research Council for a special research project in audition.

THE American Medical Association has issued a grant to W. W. Brandes and John Bagwell, of Baylor University College of Medicine, to carry out experiments on the effect of acidosis on the formation of immune bodies. A grant has also been made to Dr. L. A. Emge, clinical professor of the Stanford University School of Medicine, for the continuation of his work on "the behavior of benign and malignant transplantable tumors."

DR. L. E. NOLAND, associate professor of zoology at the University of Wisconsin, who has been working on the Ciliates at the Bass Biological Laboratory, Englewood, Fla., will take up his work at Wisconsin in the second semester.

AT a special meeting on November 29 of the Royal Society of Medicine, for fellows only, Professor George R. Minot, of the Harvard Medical School, lectured on "Some Aspects of Anemia."

THE first John Howard Appleton Lecture for 1934–1935 was delivered on December 17 at Brown University by Dr. John H. Van Vleck, professor of mathematics and physics at Harvard University, who spoke on "Some Examples of the Tunnel Effect in the New Quantum Theory."

DR. R. W. WOOD, of the Johns Hopkins University, spoke at a meeting of the North Carolina Physics Colloquium on the afternoon of December 10. That evening he addressed an open meeting of Sigma Pi Sigma physics society on "High Frequency Sound Waves."

DR. HARRY M. JOHNSON, of the American University, addressed members of the Virginia Chapter of Sigma Xi on December 7 on "Some Recent Experiments on Human Sleep."

DR. ROGER ADAMS, professor of organic chemistry at the University of Illinois, president-elect of the American Chemical Society, addressed a meeting of the New York Section of the American Chemical Society on December 7 on "Recent Trends in Applied Organic Chemistry."

THE two hundred and sixtieth meeting of the Washington Academy of Sciences will be held in the Assembly Hall of the Cosmos Club at 8:15 P. M., on December 20. The general subject will be "Introducing Science to the Public." Thomas R. Henry, of *The Evening Star*, will speak on "Science, News and Newspapers," and Austin H. Clark, of the Smithsonian Institution, on "Science and the Public."

PROFESSOR W. L. BRAGG, Langworthy professor of physics in the University of Manchester, will deliver the Children's Christmas Lectures at the Royal Institution, London, on December 27, 29 and January 1, 3, 5 and 8. The subject of the lectures will be "Electricity."

THE next meeting of the Pacific Division, American Association for the Advancement of Science, is to be held in Southern California under the auspices of the University of California at Los Angeles. The dates of the meeting have been fixed for the period from June 26 to 29, 1935. Most of the affiliated societies are planning to participate by the organization of meetings for the presentation of scientific papers. Local arrangements will be in charge of the following committee: Professors S. J. Barnett, *chairman*, E. C. Moore, B. M. Allen, L. E. Dodd, F. C. Leonard, E. K. Soper and O. L. Sponsler. A preliminary announcement descriptive of the meeting will be distributed in March to all members of the association resident on the Pacific Coast and in the Far West.

OFFICERS of the American Standards Association were reelected at the recent annual meeting in New York, the president of the association, Howard Coonley, representing the Society of Mechanical Engineers, being elected for his third term. Since January, sixteen associations have become new member-bodies or associate members, representing seventeen national associations. Twenty-five individual companies have joined the association and ten corporations have voluntarily increased their dues.

THE anniversary dinner of the Royal Society, London, was held on November 30. Sir Frederick Gowland Hopkins, the president, was in the chair. Sir Hilton Young, minister of health, proposing the toast of "The Royal Society," spoke, according to the London *Times*, of the close association with practical science and administration of the department of which he is minister. The president, in reply, said in part that research funds in the hands of the society amounted to well over £600,000, and this year the so-

ciety had distributed £25,000 in support of research in very wide fields of inquiry. Even that sum was not adequate to meet all the current applications received for financial help to scientific enterprises.

THE annual conference of the British Geographical Association will be held at the London School of Economics from January 2 to 5, 1935, under the presidency of Lord Meston. The title of his address will be: "The Geography of an Indian Village."

A FOUR-DAY postgraduate course in ophthalmology and otolaryngology was held at the University of Virginia on December 5, 6, 7 and 8, sponsored by the department of medicine in the university at the request of the Virginia Society of Otolaryngology and Ophthalmology. Dr. E. Ross Faulkner, surgeon director of the Manhattan Eye, Ear and Throat Hospital; Dr. John R. Page, surgeon director of the same institution; Dr. George M. Coats, professor of otorhinology in the graduate school of medicine of the University of Pennsylvania; E. B. Burchell, of the Eno Laboratory of the New York Eye and Ear Infirmary; Dr. Bernard Samuels, professor of ophthalmology in the Cornell University Medical College; Dr. John H. Dunnington, assistant professor of ophthalmology in the Columbia University College of Physicians and Surgeons; Dr. Conrad Berens, directing ophthalmic surgeon, Light House Clinic, New York City, and Dr. John M. Wheeler, of Columbia University, director of the eye department of the New York City Medical Center, assisted in conducting the course. From the medical department of the university the following gave lectures or conducted clinics: Dr. Fletcher D. Woodward, professor of otolaryngology; Dr. Vincent W. Archer, professor of röntgenology; Dr. Oscar Swineford, instructor in internal medicine; Dr. Halstead S. Hedges, professor of ophthalmology, and Dr. Edwin Burton, instructor in ophthalmology.

AMHERST COLLEGE has received a gift of $21,000 from the Rockefeller Foundation in support of biological research, the amount being payable from time to time during the next five years and being contingent upon the expenditure by the college of about $9,600. The money contributed by the college will be used for the erection of an addition to the biology building and equipment of a zoological room for the study of specimens under controlled environmental conditions, while the money contributed by the Rockefeller Foundation will be used in maintaining qualified research assistants and two graduate student assistants.

THE ELI LILLY AND COMPANY has established under the auspices of the American Chemical Society a research award of $1,000 and a bronze medal to stimulate fundamental research in biological chemistry in the United States by a young man or woman working in a college or university. An additional amount of $150, or as much thereof as may be necessary, is available toward traveling expenses for the recipient of the award. To be eligible a nominee shall not have passed his thirty-first birthday on April 30 of the year of the award and shall have accomplished outstanding research in biological chemistry. For the purpose of this award biological chemistry is not to include immunology, clinical investigations, pharmacology, nor experimental therapeutics, and outstanding research is understood to be that which is of unusual merit for an individual on the threshold of his career.

THE biennial award of the Oberly Memorial Prize in memory of the late Eunice Rockwood Oberly, formerly librarian of the Bureau of Plant Industry, Washington, D. C., for the best bibliography in the field of agriculture or the natural sciences has been postponed until March, 1935. This prize consists of the income from $5,000 for a biennium and is awarded every two years. Those wishing to enter bibliographies in the contest should submit, before February, four copies of their bibliography to the chairman of the Oberly Memorial Fund Committee of the American Library Association, Gilbert H. Doane, librarian, the University of Nebraska, Lincoln, Nebraska.

THE program of public lectures at the New York Botanical Garden for December, January and February is as follows: "Present Day Hawaii," Mr. Ray Jerome Baker, of Honolulu. Illustrated by motion pictures. "Growing Plants in Glass Houses," Dr. Forman T. McLean, supervisor of public education. "Trinidad," Dr. Fred J. Seaver, curator. (Supplemented with motion pictures by Dr. Edmund Fulling.) "Caring for Christmas Plants," Mr. T. H. Everett, horticulturist. "Origins of Cultivated Plants," Dr. Harold N. Moldenke, assistant curator. "Plant Life on Robinson Crusoe's Island," Dr. Carl Skottsberg, Yale University. "Botanizing in Fiji," Dr. Albert C. Smith, associate curator. "Plants Utilized by the American Indians," G. L. Wittrock, docent. "Travels in Central America, Studying the Sources of Chewing Gum," Dr. John S. Karling, Columbia University. "Puerto Rico: Its Flora and Scenery," Dr. Marshall A. Howe, assistant director. "The Improvement of Cultivated Plants," Dr. A. B. Stout, director of the Laboratories. "A Trip through Wisconsin," Dr. B. O. Dodge, plant pathologist. The lectures are given on Saturday afternoons at 3:30 P. M., beginning on December 1, with the exception of Saturday, December 29.

DR. JOHN H. NORTHROP, of the Rockefeller Institute for Medical Research, writes: "In the last number of SCIENCE, reference 3, page 506, which reads "M. Kunitz and J. H. Northrop, *Jour. Gen. Physiol.* (in press)" should read "J. H. Northrop and M. Kunitz, *Jour. Gen. Physiol.*, 16: 267, 1932."

DISCUSSION

MISCONCEPTIONS RELATIVE TO THE MINERAL COMPOSITION OF PLANTS

THE recent papers[1] on a comparison of the percentage composition of the dandelion with certain other edible plants are indicative of the prevalence of the idea that the mineral composition of each species is a fixed characteristic of that species. This concept is a legacy from the teachings of Liebig known as Liebig's "law of the minimum,"[2] from which the deduction was made that the principal mineral nutrient elements are absorbed only in certain definite and fixed proportions characteristic of the species.

The influence of this concept resulted in the neglect by the majority of those investigators, who, as a means of diagnosis, made analyses of an entire plant (or plants) periodically during the vegetative season or at maturity, to support the analyses by reference to the conditions—soil, cultural and meteorological—under which the plants were grown; and who were thereby led to conclude that the results obtained were established *ad universum et ad aeternum,* whereas, in fact, analyses had been made only of a particular plant (or plants) grown in a particular soil in a particular year. In this way the extreme sensitivity, the flexibility (plasticity) and "le mode d'alimentation" of a plant, readily recognized by the method of foliar diagnosis,[3] were not clearly discerned.

The fact that has been hitherto and is still at present lost sight of is that comparison of the quantitative relations between the elements during the growth of a particular species subjected to different growth conditions—cultural and meteorological—can not be made without a key of interpretation and that consequently comparisons between the composition of different species with respect to any of the dominant or accessory mineral elements also can not be made without a key of interpretation. The problem for the future is to work this out.

WALTER THOMAS
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THE ACID-BASE EQUILIBRIUM IN SEA WATER

SINCE the fundamental vital reactions of metabolism and photosynthesis proceed through the oxidation and reduction of carbon, it is important to describe the condition of the oxidized forms of carbon in the environment. In sea water carbon dioxide dissociates as an acid, with results which are directly of biological importance; and, indirectly, they are of no less significance in relation to the solubility and precipitation of calcium carbonate.

There have been numerous attempts to formulate the carbon dioxide system in sea water in terms of the dissociation products of carbonic acid. These have differed in one important way in essential procedure. In one case sea water has been regarded as a solution containing only the weak acid, carbonic.[1] In the other case, sea water has been considered as containing other weak acids than carbonic which are non-volatile.[2]

Proceeding upon the assumption that the only weak acid present is carbonic, titration with strong acid to the proper end point will indicate the quantity of combined carbon dioxide present, and the results so obtained may be utilized to indicate bicarbonate ion concentration for the calculation of the first apparent dissociation constant. If, on the other hand, another weak acid is present, titration will give results for the combined carbon dioxide content of the solution which are too large. The error of the carbon dioxide content so calculated will depend upon the amount of strong acid necessary to deionize the weak acids other than carbonic.

Since the titration alkalinity of the sea water is small (2.5 milli-equivalents per liter), it is not easy to be certain from the titration curve whether or not other weak acids are present. More recently it has been determined that boron is present in sea water to the extent of about 0.4 millimols per liter.[3] Phosphoric and silicic acids appear to be present in too small an amount for significance, but it is difficult to exclude them entirely.

The extensive work of Saunders (1926) and Buch *et al.* (1932) derives the value of k_1 for carbonic acid in sea water from determination of the total CO_2 by titration. The results obtained by titration should give values for bicarbonate, and consequently k_1, which are too large in proportion to the amount of acid required for deionization of weak acids other than carbonic. At the same time it is recognized that the effect of the half molar salt concentration will be to reduce the bicarbonate ion activity, and a correction is applied to reduce the value of k_1. The sum of the positive error due to other weak acids and the negative activity correction perhaps bring the final result for k_1' to its true value, but the result is fortunate rather than correct. That the results are

[1] E. Bennett, SCIENCE, 80: 142, 1934; G. E. Youngburg, *ibid.*, 80: 337, 1934.
[2] Walter Thomas, SCIENCE, 70: 382–384, 1929.
[3] Walter Thomas, *Soil Science,* 33: 1–20, 1932; and the references to the papers by H. Lagatu and L. Maume cited therein.

[1] Saunders, 1926; Buch *et al.*, 1932; Greenberg, Moberg and Allen, 1932.
[2] Henderson and Cohn, 1916; Irving, 1925.
[3] Moberg and Harding, 1933; Buch, 1933.

consistent with theory on such assumptions is only a demonstration of consistent analytical operations.

The error is unfortunately introduced in the assumptions necessary for derivation of the first constant in the system. It enters the calculation of k_2' for carbonic acid and k' for boric acid as determined by Buch (1933).

There are so many uncertainties in the application of the law of mass action to the dissociation of weak acids that it is better to remember that the whole system is only empirical and that it is only significant as far as the analytical procedure is directly appropriate. The statement that

$$\text{Total } CO_2 = \frac{\alpha P}{760}\left(1+\frac{k_1}{[H^+]}+\frac{k_1k_2}{[H^+]^2}\right)$$

affords the chance for direct determination, since at pH 7.0 the last term is negligible and all others but k_1 can be determined analytically. As determined in that way the value of k_1 and its derivatives k_1' and k_2' would have empirical significance corresponding to the accuracy of analytical procedure.

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HOST RESPONSES TO HAUSTORIAL INVASION OF CUSCUTA SPECIES[1]

WORKING on the host responses to haustorial invasion of *Cuscuta* the writer noted, in 1931, that galls were frequently formed by the host plants. Extended observations in the field during the past three years, and controlled experiments in the greenhouse, show that infestation of a given host plant commonly leads to marked hypertrophy of adjacent tissues, resulting in gall formation. Large, primary galls are characteristically formed at the point of initial attack, similar swellings at points of secondary infestation, and other types of hypertrophy at various points of haustorial entry on the same plant.

In all, 334 galls have been collected by the writer, 107 from field stations in Iowa and West Virginia, while 227 were formed following experimental greenhouse infestations. Four species of *Cuscuta* have been observed to induce gall formation, namely, *C. Gronovii* Willd., *C. glomerata* Choisy., *C. rostrata* Shuttlw., and *C. Polygonorum* Englm. The following seventeen genera (containing 21 host-species) have been listed as gall-forming hosts to one or more of the above-named dodders, *viz., Hibiscus, Salix, Solidago, Stachys, Cucurbita, Glycine, Fagopyrum, Helianthus, Cucumis, Chelone, Medicago, Trifolium, Cephalanthus, Impatiens, Myriophyllum, Nicotiana* and *Bidens*.

Young galls consist mainly of hypertrophied cortical tissues; later stages involve an increase in volume of both cortex and xylem, the latter often enlarging greatly and frequently making the galls quite woody. The surface of the older galls is commonly cracked, roughened or fissured and frequently supports a superficial fungus growth. However, no traces of fungi or bacteria have been found in the inner tissues of any gall examined by the writer.

In previous studies of *Cuscuta* primary attention has been given taxonomic and agricultural phases with, of course, a few critical studies on the structure and penetration of the haustoria. Galls apparently have escaped previous notice because of their usual occurrence low, on the host stem, within a few inches of the ground. However, Peirce[2] reported an example in which the petiole of *Solanum jasmoides* showed a general enlargement due to haustorial entry. In the same article he stated that host plants of *Cuscuta* did not form new structures or exhibit new growth as a consequence of haustorial penetration.

H. L. DEAN

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[1] Preliminary report.

BOHEMIUM—AN OBITUARY

THE sensational announcement[1] by Odolen Koblic that he had found in pitchblende a new element, atomic number 93, atomic weight circa 240, created a considerable stir in the ranks of chemists and physicists. However, "bohemium" lived only about one month, and the undersigned was in some measure responsible for its speedy demise. My teacher, Seubert, had studied under Lothar Meyer, who shared with Mendeléeff the honor of formulating the periodic system of the elements. Brought up in this school I was, of course, greatly interested in the report that the family of our chemical building stones had been once more increased and that the newcomer represented an extension of the periodic arrangement.

Frankly, I was skeptical, and I made a special trip to Joachimstal, C. S. R., visited Koblic in his laboratory and persuaded him to give me some samples of "bohemium"-bearing material. These were taken to the Physikalischtechnischen Reichsanstalt in Berlin and turned over for investigation to that gifted couple, Walter and Ida Noddack, the discoverers of rhenium and masurium.

The x-ray spectrographic study gave absolutely negative findings. Neither the Noddacks nor their expert collaborators could detect the slightest indication of the presence of a new element in the "bohemium" concentrate. The optical spectroscopic tests revealed nothing in favor of Element 93. Chemical tests showed that the specimens consisted chiefly of tungsten, vanadium, etc. Later work showed that

[2] G. J. Peirce, *Ann. Bot.*, 8: 53–118, 1894.

[1] *Chemiker Zeitung*, July 18, 1934, page 581.

tungsten was responsible for the observations that had led Koblic into his statement. He admitted his error and withdrew his claims.[2] The Noddacks deserve the gratitude of the scientific world for the decisive manner in which they proved the falsity of these claims.[3]

MAX SPETER

BERLIN

SCIENTIFIC BOOKS

A HISTORY OF FRENCH SCIENTIFIC SOCIETIES

Scientific Organizations in Seventeenth Century France (1620–1680). By HARCOURT BROWN. xxii + 306 pp. History of Science Society Publications, No. 5. Baltimore: The Williams and Wilkins Company, 1934. Price $3.00.

THIS is primarily a history of the scientific societies, that is, of private assemblies of the amateurs of the natural sciences rather than of the Académie Française and the Académie des Sciences in the seventeenth century in France. These constituted a succession of associations, clubs, conferences and assemblies long known but whose influence and meaning has hitherto been unanalyzed. From them came a multitude of essays and publications forming the bulk of the popular scientific literature of their day. Their history lies in the archives and manuscripts of Western Europe, often in other countries than France. They are the heirs of the Platonic tradition of free assembly and corporate activity outside of political control or governmental origination and support. To the tradition of the academy, museum and lyceum of the philosophic schools of classic period they added cooperation in the practical arts. This appears in an active interest in discoveries and inventions, the provision of a place for the trial of new methods, for experimentation, for the accumulation of the comforts and conveniences of life and sometimes for the secrets of the practitioners of the arts from astrology to ship-building. They thus avoided some of the opposition which the greater and more intellectually powerful academies were arousing in royalty, the church and in organized medicine, such as Dr. Henry Stubbs' assaults on the Royal Society of London, inspired and perhaps paid for by Dr. Harvey, patron of the College of Physicians. The membership of these minor societies in France not infrequently exercised their freedom in criticism of their compatriots in the more august academies. Under their fostering care they gave a widened diffusion to the sciences and the arts, stimulated thought, inspired criticism and contributed to the progress of the standards of living and culture between the Renaissance and the Encyclopedia of Diderot. The turmoil of war after 1680 interrupted their contacts abroad, restricted their activities at home and effectually obliterated their further influence.

The impetus to the interest in science originated in the skepticism of Montaigne, but the organization followed Italian models and gained power through the prestige of the city of Paris. The chief link with Italy was Peiresc (1580–1647), a student at Padua, a traveled scholar and patron of the arts. He had five telescopes, collected plants, fossils and crystals, carried on dissections, discovering the chyle ducts, distrusted astrology; was a patron of letters, but his discoveries remained in manuscript.

The brothers Dupuy, historians, librarians and lovers of books, were the founders of the Cabinet Dupuy. Its library, the Fonds Dupuy, is now in the Bibliothèque Nationale. This cabinet was the center of free discussion of the intelligentsia of France. Its members sought in its meetings intelligent and authoritative reports of the world at large. It established the tradition for the patrons of learning later followed by Ménage, Justel and others.

The weekly pamphlets published (1633–1642) by Renaudot, and reported as *Conférences du Bureau d'Addresse,* originated in a popular enterprise combining the features of a pawnshop, auction house, free clinic and information bureau. This is reported to be the first serial of scientific nature; though scoffed at and criticized by the learned professions, it nevertheless afforded a free medium of information and a form for the discussion of current ideas. The serial was translated and published in London in 1664–1665 in an obvious response to the public interest in the newly founded Royal Society and stimulated the opening of the Office of Intelligence in London in 1638. The hostility of the medical profession caused the legal suppression of the enterprise in Paris in 1644.

The Renaudot enterprise forwarded the decline of Latin as the medium of scientific publication in favor of the modern languages. Mersenne, the Huguenot monk, also forwarded this with his extensive correspondence, his conferences of physicists and mathematicians, and his liaison relationships between the more conservative forces of his time and the devotees of the new sciences. His Europe-wide relations, his liberalism and his rationalism did much to develop and maintain the freedom of discussion in his day, even though his cautious circumspection at times clothed the replies to his penetrating questions with a

[2] *Chemiker Zeitung,* August 22, 1934, page 683.

[3] Translated by Ralph E. Oesper, University of Cincinnati.

mass of protective verbiage. Mersenne was a correspondent of Haak, an associate of Pell, Comenius, Ward, Digby, Cavendish and Hartlib in London, a relationship influential in the founding of the Royal Society of London, an influence heightened by his controversy with and antagonism to the medievalist, Fludd.

To the Montmor Academy has been attributed a dominant influence in the foundation of the Royal Society of London. This our author contests, though admitting that Oldenburg had once attended one of its meetings. He marshals evidence, on the other hand, that the Royal Society was influential in inspiring this French organization to propose a government-sanctioned academy at Paris. But when Colbert did establish the Académie des Sciences he omitted many of the contentious members of the Montmor group and selected the membership on narrower lines than the London group, cautiously avoiding the opposition of the Jesuits, the medical profession and other vested rights in intellectual leadership.

The closing chapters deal with the conferences of Henry Justel, the origin and growth of scientific publications and the relations of science to the press. This scholarly treatise is replete with data concerning this most significant period in the emergence of modern science, and its critical analysis of these wider influences tributary to its growth is a welcome addition to the history of science.

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THEORETICAL PHYSICS

Introduction to Theoretical Physics. By J. C. SLATER and N. H. FRANK, McGraw-Hill Book Company, pp. xx, 576, $5.00, 1933.

IN this notable work Professors Slater and Frank, of the Massachusetts Institute of Technology, offer a text of intermediate grade which carries the reader through classical physics far into the intricacies of the wave mechanics. The first 328 pages are devoted to classical physics and the remaining 248 pages to quantum theory. As might be expected, the authors lay greatest stress on those problems of classical physics which exhibit the mathematical methods which are employed later on in the development of wave mechanics. Thus the theory of coupled oscillators, the vibrations of a string with variable tension and density, the vibrations of membranes and the like are treated in considerable detail. The authors are to be congratulated on the clearness and perspicuity of their development of the subject, and on the excellent exposition of even the more difficult portions of quantum theory which they have made available to the student whose mathematical equipment is limited to the elements of differential and integral calculus. In the part of the book devoted to wave mechanics they take up in addition to the theory of hydrogen-like atoms such topics as perturbation theory, many-electron atoms, interatomic and molecular forces, quantum statistics, molecular structure, collisions and chemical reactions, electronic interactions, electron spin, Fermi statistics and metallic structure, and the quantum theory of dispersion. The book is divided into a large number of short chapters each of which contains one or two closely related subjects; an excellent arrangement from the pedagogical view. At the end of each chapter is a collection of relevant problems, which provide the student with an excellent test of his understanding of the textual material. The most notable omissions in the text are the relativity theory and the electromagnetic theory of mass. The special relativity has played such an important part in modern physics that at least the development and interpretation of the Lorentz transformations might be expected to be found in a work of this grade. On the other hand, theoretical physics has become such an extensive subject that no author can attempt to cover all its important aspects in the compass of a single volume.

Particularly as regards the first part of the book, it seems to the reviewer that "Mathematical Methods in Physics" would describe the contents better than the title chosen by the authors. For the emphasis is rather on the analytical methods suitable for the solution of physical problems than on the logical development of physical theory. In many cases the authors utilize examples from various branches of physics to illustrate the analytical procedure under discussion, rather than subordinating the mathematical process of solution to the continuity of development of the physical theory. On the other hand, the authors are too prone to omit the proof of an important physical result in order to avoid analytical details. This procedure is not always satisfactory to the intelligent student, who is often as interested in the reasoning by which the result has been established as in its significance and interpretation.

There are few statements in the text to which the teacher can take exception. The one which is likely to create the most unpleasant reaction is the reference on page 16 to the back e.m.f. of resistance.

Altogether the book is a notable contribution to the increasing number of texts in intermediate physics, and unique in its masterly presentation of quantum mechanics. It will be of inestimable service in introducing the student to this most important branch of physical science.

LEIGH PAGE
YALE UNIVERSITY

REPORTS

THE SECOND ANNUAL TRI-STATES GEOLOGICAL FIELD CONFERENCE OF THE UPPER MISSISSIPPI VALLEY

THE second Tri-States Geological Field Conference of the geologists of Illinois, Iowa and Wisconsin was held in the region of Madison, Wisconsin, on October 20 and 21, 1934, with 124 geologists and a few visitors participating. Large groups came from the University of Chicago, Northwestern University, the University of Illinois, the Geological Survey of Illinois and the Geological Survey and University of Iowa. In addition, many of the small colleges of the three states sent one or more representatives. The two-day field trip was under the direction of Loyal Durand, Andrew Leith, G. O. Raasch, R. R. Shrock and F. T. Thwaites, with the general supervision under the direction of W. H. Twenhofel.

The field party left Madison at 9 A. M. on October 20 in forty cars. There was first visited the Johnstown Moraine, the outermost or terminal moraine on the east side of the Driftless Area. Thence was studied the section from the St. Peter sandstone to the Maquoketa shale. This was seen at various points on the south side of the Wisconsin Valley in the region of Mt. Horeb and Blue Mounds. The highest strata of southern Wisconsin, the lower part of the Niagaran dolomite, here replaced by chert, caps the top of West Blue Mound. This is the highest elevation in southern Wisconsin (1,716 feet). East Blue Mound is capped by the Maquoketa shale.

The party crossed over East Blue Mound and thence went north and west to the Wisconsin River, passing downward through the section to the Galesville member of the Dresbach formation, exposed on the Wisconsin River in Tower Hill State Park—a nearly complete section of the Cambrian and the Ordovician thus being seen to this point. This section consists of formations as follows:

Silurian
- Niagara dolomite (not Mayville)

Ordovician
- Maquoketa shale
- Galena dolomite
- Decorah shale
- Platteville limestone
- St. Peter sandstone
- Shakopee dolomite (not proved to be present)
- New Richmond sandstone (not proved to be present)
- Oneota dolomite

Cambrian
- Trempealeau formation
  - Madison-Jordan sandstone
  - Lodi siltstone
  - St. Lawrence dolomite
- Franconia formation
- Dresbach formation
  - Galesville sandstone

Lunch was had at Tower Hill State Park, a place of historical interest because of the manufacture of shot at that place in the early days. The old shot tower cut in the sandstone is still in existence.

On the afternoon of the same day the country north of Spring Green, Wisconsin, was studied and parts of the section seen in the morning were again examined. In the middle of the afternoon the party reached the summit of the Lower Magnesium Upland on the north side of the Wisconsin Valley. This upland area is cut on a strata of the Lower Magnesian dolomites (Shakopee and Oneota dolomites). At a higher elevation remnants of another upland may be seen. Mr. Thwaites presented the various explanations which have been offered to account for the uplands.

The most southwestern exposure of the Huronian Baraboo quartzite was seen at Weidman Falls, where the erosion of a stream superimposed from the Cambrian upon the quartzite has brought the latter to the surface. Finally, late in the afternoon, extensive exposures of the Baraboo quartzite, conglomerates of the Paleozoic strata at the contact with the quartzite, the fracture cleavage of Van Hise rock and other features of the section were studied in the Upper Narrows of the Baraboo River.

The party spent the night in Baraboo, and a banquet attended by 83 members of the conference was served. After the banquet there was chosen a committee to organize the conference for 1935, consisting of A. C. Trowbridge, *chairman,* representing Iowa, M. M. Leighton, representing Illinois, and W. H. Twenhofel, representing Wisconsin. The 1935 conference will be held in Iowa.

Sunday morning, October 21, was spent in the Baraboo Range. Attention was called to the differences in the lithology of the Cambrian strata within the Range and the fact that at the contact with the Baraboo quartzite every formation becomes a conglomerate and that the assignment of all the conglomerates to the Cambrian is not correct. There were examined in order shaly strata in the Franconia formation, highly burrowed sandstones in the upper part of the same formation, the intrusive granite of Baxter Hollow, the highly contorted and deformed strata in the upper part of the Baraboo quartzite exposed on the headwaters of Skillet Creek, fracture cleavage exposed in the quartzite on the northern end

of Devils Lake, and, lastly, the schistose and massive rhyolites exposed on the Lower Narrows of the Baraboo River, at which place the quartzite is in vertical position and likewise the original surface of the rhyolite on which deposition took place. No evidence of incorporation of rhyolite fragments in the quartzite was found.

The conference adjourned at 1 P. M. on Sunday, October 21.

W. H. TWENHOFEL

SCIENTIFIC APPARATUS AND LABORATORY METHODS

A PHYSIOLOGICAL STROBOSCOPE

A NEW physiological stroboscope has been developed primarily for the study of the vocal cords during phonation. Stroboscopy, in this application, dates to a suggestion of Töpler[1] in 1866 and its first utilization by Oertel[2] in 1878. However, the instrumentation to date, although having seen much change in form, has shown little change in principle from that of original conception. These apparatus essentially consist of a light source of rapid quenching characteristic, some means for interrupting the light such as a shutter or switch, and a variable speed motor or actuator capable of covering the frequency range of the voice. A further elaboration provides for a tone source or loud speaker in conjunction with the interruptor, whereby the subject has established for him the tone frequency he is to take.

In contra-distinction, the authors' apparatus permits the subject to take any tone or series of tones arbitrarily, and the stroboscope automatically responds to the variation as it occurs. Inasmuch as no manual adjustment or compensation is necessary for the reestablishment of syntony upon a variation of frequency, either in the voice or the mechanism of interruption, it is possible to follow the cordal configuration throughout a tonal transition. Thus a limitation of large proportion has been lifted from this field of study.

A microphonic pick-up element, a series of band pass filters, a high gain amplifier, a set of phasing impedances and an oscillator with the output feeding a gaseous discharge lamp substantially comprise the instrument. The phasing circuit permits the study of the cords during any portion of the cycle from the fully closed to the fully opened positions. Entrance into the viewing position is accomplished with an endo-laryngoscopic device which has been fitted with the gas discharge lamp.

A series of investigations utilizing the instrument has been projected and reports will follow.

LEO A. KALLEN
H. S. POLIN

DISSECTION AS A METHOD OF EMBRYOLOGICAL STUDY

AT the meetings of the American Association for the Advancement of Science held in Berkeley in June of this year one of the demonstrations was an exhibit of most of the equipment for the dissection and stereoscopic photography of embryos, together with a display of stereoscopic photographs of various dissections of the developing rat. Although a detailed description is being prepared, the following summary is offered.

The chief pieces of apparatus consist of the following: A specially designed lamp, for using flashlight bulbs, by which light is concentrated to a small spot at a distance of 7 inches from the lamp; an electrically operated vibrating knife, made from a piece of safety razor blade, supported and controlled by racks and pinions; a dissecting needle fashioned from a hypodermic needle mounted on a system of levers so that the motion is reduced by about 4; ball and socket mounts for holding embryos during dissecting and during photographing. The camera bellows consists in part of a telescoping bellows and in part of boxes by which the total length can be increased to about 6 feet. It is supported on a long piece of steel tubing which in turn is so mounted vertically that it can be inclined to right and to left in order with the same lens to take in succession two different photographs of the same embryo, which give a stereoscopic effect. A support for the embryo so that it can be kept in the axis of inclination of the camera and also be illuminated from beneath as well as from above.

Other items include such things as fine-tipped forceps, brushes made of fine silk thread, turn table, etc.

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THE DEVELOPMENT OF THE PRINCIPAL ARTERIAL VESSELS IN THE RAT FROM 11 TO 16½ DAYS

THIS study traces the vascular changes through a critical period of development and determines the embryonic relationships of certain adult vessels. It also offers a reconciliation of inconsistent embryological terminology with the B.N.A. as used by Greene.[1]

The embryos were injected with diluted India ink, dehydrated, dissected in benzol, for which a method was devised, and finally cleared by Reagan's modified

[1] Topler, *Annalen d. Phys. u. Chem.*, p. 108, 1866.

[2] M. J. Oertel, "Uber eine Neue Laryngo-Stroboskopische," *Zentral. Med. Wiss.*, 1878.

[1] The writer wishes to gratefully acknowledge the generous cooperation of E. C. Greene in advancing information from her manuscript on the anatomy of the adult rat soon to be published.

Spalteholz technique.[2] Illustrations are stereoscopic photographs made as described by Long.[3]

The aortic arches exhibit the greatest development and remodeling during this interval, while the head vessels undergo extensive rearrangements. The major features of Tandler's[4] work is confirmed and extended to later stages. A summary of the development of the vessels to the limb buds and visceral organs is included.

The need for a standard and consistent nomenclature which takes into account both embryonic structures and their adult derivatives is discussed.

This is a preliminary note on an extensive study now in preparation for the press.

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THE REMOVAL OF FLUORIDES FROM WATER BY SAND FILTRATION

SINCE it has been established that the dental disease in man known as "mottled enamel" is due to the drinking of water containing fluorine, the removal of fluorides by filtration has become an important problem.

I have found that a contact filter 15 cm high, made of river sand passing a screen 60 to the inch, to which has been added 2 per cent. by weight of powdered aluminium, will remove the fluoride from a solution containing 30 parts per million of sodium fluoride. The absence of fluoride in the filtrate was determined by the zirconium-alizarin colorimetric method.

S. P. KRAMER

FT. THOMAS, KY.

SPECIAL ARTICLES

RARE GASES NOT ESSENTIAL TO LIFE[1]

HERSHEY[2] reported that small animals such as rats could not survive more than a week approximately in an atmosphere of 21 per cent. oxygen and 79 per cent. nitrogen in which the rare gases were left out. He concluded that helium, argon, neon, krypton and carbon dioxide were vital to normal respiration and life. Fidlar,[3] accepting the results reported by Hershey, conceived of the rare gases playing a rôle in the atmosphere similar to the vitamins in foods. Previously, Ramsay[4] considered these gases inert biologically.

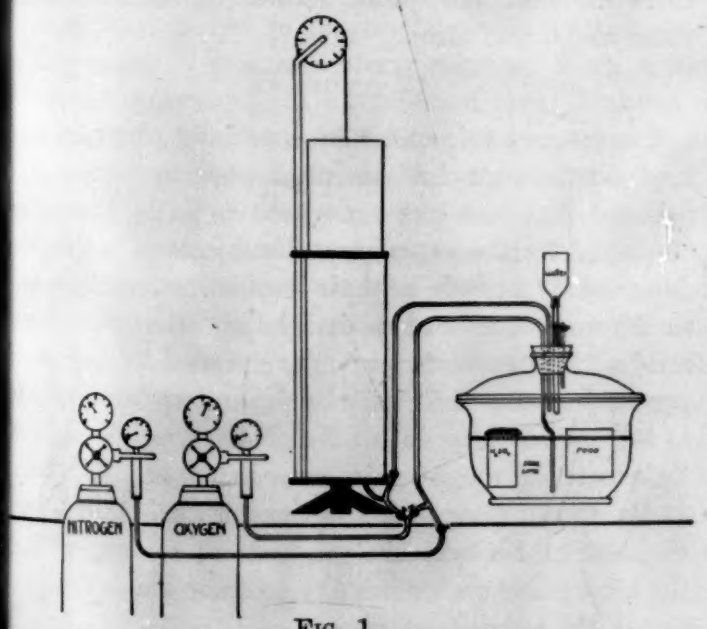

FIG. 1

Through the assistance of the engineering staff of the Linde Air Products Company, oxygen and nitrogen were especially prepared in order to exclude the rare gases. Oxygen was made from electrolytic dissociation of water. The nitrogen was produced by cracking ammonia and removing the hydrogen by control combustion with electrolytic oxygen. Both gases were prepared for the following purpose only, and every precaution exerted to secure pure oxygen and nitrogen. After the work was commenced, it was found that the nitrogen employed by Hershey was not free from rare gases. Nevertheless, it was thought desirable to determine whether these so-called inert gases had any detectable biological activity in the animal organism.

The problem presented the additional possibility of throwing a light on the cause of death in animals continuously exposed to from 80 to 100 per cent. oxygen for two to five days. Lorrain Smith[5] was the first to point out that fatal pulmonary lesions characterized by edema and finally consolidation took place when animals lived for periods exceeding two to three days in these high oxygen atmospheres. Although Hershey submitted no autopsy protocols of the animals who died presumably in the absence of rare gases, the hypothesis was apparent that perhaps the high oxygen atmospheres achieved a relative exclusion of rare gases. Smith's work was confirmed and amplified by many others[6-9] without affording

[2] F. Reagan, *Univ. Calif. Publ. Zool.*, 28: No. 18, 1926.
[3] J. A. Long, SCIENCE, this issue.
[4] J. Tandler, *Morph. Jahrb.*, 30: 275–373, 1902.
[1] From the Department of Medicine, College of Physicians and Surgeons, Columbia University, and the Presbyterian Hospital, New York City.
[2] J. Willard Hershey, *Trans. Kansas Academy of Science*, 32: 51, 1929; *ibid.*, 33: 133, 1930; *ibid.*, 34: 240, 1931; *ibid.*, 35: 141, 1932. SCIENCE, 71: 394, 1930.
[3] Edward Fidlar, SCIENCE, 72: 296, 1930.
[4] Ramsay, "The Gases of the Atmosphere."
[5] Lorrain Smith, *Jour. Physiol.*, 24: 19, 1899.
[6] L. Hill and J. J. R. Macleod, *Jour. Physiol.*, 29: 492, 1903.
[7] H. T. Karsner, *Jour. Exper. Med.*, 23: 149, 1917.

any explanation of the death of animals exposed to high oxygen except that the lungs reacted as if to an irritant. In the author's investigations of the subject,[8] it was shown that animals (rabbits) were alive and well at the end of three months' residence in 60 per cent. oxygen. There were no demonstrable effects except a decline of approximately 15 per cent. in hemoglobin and red blood cells. However, it was not possible, even after long exposure to this oxygen concentration, to build up a tolerance to 80 to 100 per cent. oxygen. Between 70 and 80 per cent. oxygen, some animals in one to two weeks show edema of scattered alveoli, whereas the lungs of others appear normal. Below 70 per cent. continuous residence in high oxygen atmospheres appears safe and above 80 per cent. uniformly harmful. Whether the rare gases were diluted to an extent that made pure oxygen irritating was considered a hypothesis that was clarified by the experiments which follow.

METHODS

A glass jar of eight liter capacity was employed to house two white mice. Bran, mash and oats were provided as food. Water was administered by an inverted bottle, as shown in the diagram. Water vapor was removed by the presence in the glass jar of 250 cubic centimeters of sulfuric acid. Carbon dioxide was absorbed by soda-lime, four pounds being installed at a time. After the mice were admitted, the jar was sealed with lubriseal. The air within the jar was washed out by running in pure electrolytic oxygen for one and a half hours, at a rate of six liters per minute. Pure nitrogen was then added to make an atmosphere of 21 per cent. oxygen and 79 per cent. nitrogen. Special precautions were carried out in testing the atmosphere to guard against any air contamination. Twice a week the air was changed by the same process without removing the lid of the glass chamber. Once a week the food was replaced and the chamber cleaned, which occupied about fifteen minutes. Daily tests of oxygen and carbon dioxide demonstrated the absence of accumulation of carbon dioxide and the absence of leaks. The oxygen concentration remained constant. The inlet of oxygen was furnished from a spirometer which was in a water and oil seal. Measurements of the total oxygen consumption for twenty-four hours were made on the experimental and on control animals.

RESULTS

In early experiments, the mice died within six or seven days, the glass chamber atmosphere at the time of their death showing a remarkable decrease in its oxygen content. When the animals were found dead in the morning, an apparent oxygen consumption of twice normal was accompanied by a decrease in the oxygen concentration of the atmosphere to about four to six per cent. It was discovered that water had come in contact with the bran mash and that a fermentative process had developed with the production of 30 per cent. carbon dioxide. This accounted for the loss of oxygen and the consequent death of the mice.

In the experiments which were made following this experience, the water was separated from the mash, which was reduced in amount. The fermentative process was thus avoided.

In the first experiment, one mouse was alive on the seventeenth day and one died, the cause of death not discovered. The second mouse was then killed and autopsied.

A second experiment was conducted for thirty-two days, both mice being then apparently well. They were autopsied. A third experiment was carried out, four mice being treated in two separate chambers. All four were living and apparently well at the end of forty days.

The weight of all the animals kept in the chamber showed a gradual gain comparable to control mice in the animal room.

The oxygen consumption which varied for two mice between 3,500 and 4,500 cubic centimeters per 24 hours was not significantly altered before or during the inhalation of the atmosphere in the chamber.

Pathological sections of the lungs, heart, liver and in two animals the spleen, showed no deviation from those of normal mice.

CONCLUSIONS

Oxygen and nitrogen were especially prepared free from the rare gases of the atmosphere to test the hypothesis that rare gases are vital to life. Mice were employed as the experimental subjects. A chamber designed to exclude any air contamination was used to house two mice at a time in an atmosphere containing 21 per cent. pure oxygen and 79 per cent. pure nitrogen. Mice were living and apparently well at the end of forty days. No change was observed in their rate of weight gain, oxygen consumption over 24 hour periods or in the sections of their lungs, liver and heart. No evidence was secured to suggest that the rare gases were necessary to the biological activities of the animal organism.

The cause of death in oxygen poisoning is probably without relation to any dilution of rare gases that might take place in a high oxygen atmosphere.

The author acknowledges the technical assistance of Morris Eckman.

ALVAN L. BARACH

[8] A. L. Barach, *Am. Rev. Tuber.*, 13: 293, 1926.
[9] C. A. L. Binger, J. M. Faulkner and R. L. Moore, *Jour. Exper. Med.*, 45: 849, 1927.

CHROMOSOME STRUCTURE IN THE SALIVARY GLANDS OF SCIARA[1]

BELLING, in a series of papers,[2] strongly supported the hypothesis that chromioles in chromosomes represent gene loci, but was unable in his material (lilies) to make the necessary genetic tests to identify individual chromioles with individual genes. Recently attention has again been directed to this subject by the finding of Heitz and Bauer,[3] of Painter[4] and of King and Beams[5] that the deeply staining cross bands or disks, long known to be visible in the salivary gland "spireme" of Diptera, represent a definite architecture and may, like the chromioles, be identified individually in different chromosomes. Painter has shown further that in *Drosophila* these bear a definite relation of some kind to gene loci, and Koltzoff[6] has suggested that the small granules visible in the "disks" or rings probably represent the genes or the spaces between the genes. According to press reports[7] and personal communication, an essentially similar interpretation has been developed by Bridges. On the view of Bridges and Koltzoff each of the large salivary gland chromosomes is compound and represents a bundle of slender gene strings which have been derived by repeated division of an original gene string (or pair of strings) and each disk or ring is a rosette, made up of the genes derived from one original gene (or pair). Threadlike lines have been described connecting the granules in successive bands or disks as required by the hypothesis (Koltzoff).

In this interpretation no reference is made to the claim of earlier investigators, such as Alverdes[8] and Kaufmann,[9] that the disks or rings in the chromosomes are present in pairs. If such a paired condition exists it requires interpretation. With a view toward throwing light on this and other features, as well as of identifying individual chromosomes in our material, we have made careful observations on the salivary gland chromosomes in *Sciara*. Although the study is by no means complete, certain features have been observed which seem to warrant brief note at this time. In material fixed and stained in the usual iron-aceto-carmine mixture we have obtained distinctly different appearances after different modes of treatment. Dissection in Ringer's solution or tap water gives conditions resembling those previously described. The chromosomes contain bands or disks of various sizes ranging down to very thin lines or rows of granules. Many of these are in pairs.

[1] From the Department of Embryology, Carnegie Institution of Washington, and the Department of Zoology, Johns Hopkins University, Baltimore, Md.

[2] *E.g.*, *Univ. of Calif. Pub. in Bot.*, 14: 307, 1928.

[3] *Zeits. f. Zellf. u. mik. Anat.*, 17: 67, 1933.

[4] SCIENCE, 78: 585, 1933; *Genetics*, 19: 175, 448, 1934.

[5] *Anat. Rec.*, Sup., p. 89, 1933.

[6] SCIENCE, 80: 312, 1934.

[7] *New York Times*, September 17, 1934; *Science News Letter*, September 29, 1934.

After dissection in body fluid or directly in the aceto-carmine mixture, however, the chromosomes often contain a series of what appear to be compressed biscuit-like or wafer-like vesicles. These vesicles likewise range in size down to mere lines or rows of "granules" (Fig. 1, *A*). And like the bands

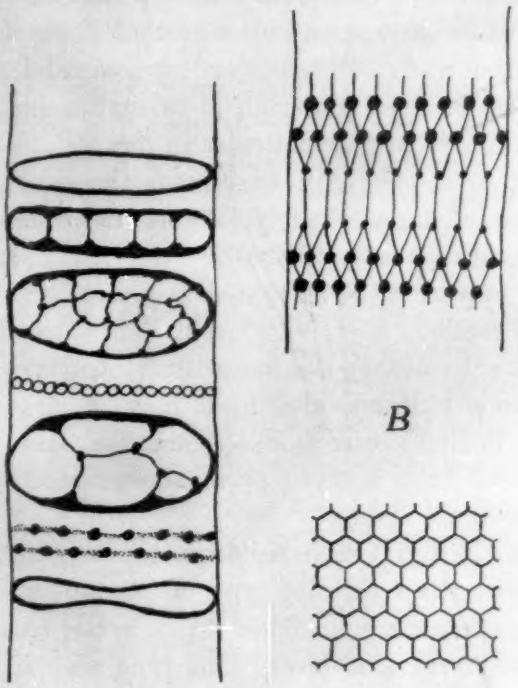

FIG. 1

or disks they exhibit a constancy in organization, corresponding in homologous regions of homologous chromosomes. Under suitable conditions both disks and vesicles may be secured in the same chromosome. In some cases at least it seems clear that a vesicle represents a pair of disks, together with the intervening material, and that the two faces of the vesicle correspond to the two disks.

The segments or vesicles appear in fixed material to be vacuolated or alveolar in structure. Their faces often appear granular, like the disks. The granules, in such cases, appear to bear a definite relation to the "alveolar" structure. The granule, or thickening, lies at the junction of two or more "alveoli," as indicated in the accompanying figure 1, *A*. Thus the number of granules bears a definite relation to the number of alveoli, and each alveolar wall or interface may make a thread-like connection across the vesicle connecting two granules on opposite faces. By focusing, the granules may often be followed along the alveolar junctions, up the faces of the vesicle and across the top, where those from opposite faces meet. Such "granules" are clearly long and slender. We have not found them consistently arranged about the axis of the chromosome like spokes of a wheel.

In material prepared so as to bring out the disk or

[8] *Arch. f. Zellf.*, 9, 168, 1912.

[9] *Amer. Nat.*, 65: 555, 1931.

banded structure many of the "bands" are represented by what appear to be rows of granules across the chromosome, and in some cases faint longitudinal lines appear to connect granules in successive bands, giving the impression of strings of beads, as described by Koltzoff. This is particularly true where a chromosome has been stretched. Careful study of the finer structure in such cases indicates that these lines represent the walls of "alveolar" spaces, and that the structure, in fixed material, is in reality honeycomb-like, as indicated schematically in figure 1, *B*. In the clearest cases we have examined, the lines are not continuous, but forked, following the walls of the (often hexagonal) "alveoli." In some cases the alveoli appear to be elongated in a more or less diagonal direction, suggesting that the chromosome is twisted. In others the honeycomb structure is comparatively uniform and lines may be traced diagonally in both directions (clockwise and counterclockwise) from a given point as indicated schematically in figure 1, *C*.

In our material each region in the chromosome appears to have a definite type of protoplasmic structure which usually extends through the chromosome transversely at that level. The type may change abruptly in passing from one region to another. At some places the protoplasm appears to be essentially homogeneous, while at others the appearance of fine or coarse alveolation is evident, suggesting that qualitative chemical differences are associated with the morphological differences.

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DEMONSTRATION OF THE EXISTENCE OF TWO FORMS OF VITAMIN D IN FISH LIVER OILS

SINCE the discovery that the vitamin D of irradiated ergosterol is different from that of cod liver oil, the latter form has sometimes been distinguished by such terms as "natural vitamin D" or "fish oil vitamin D." The implication that the vitamin D naturally occurring in different fish oils is always the same qualitatively has been put to test, with the surprising observation that fish oils differ qualitatively as well as quantitatively in their vitamin D content.

To distinguish the two forms in fish oil we employed essentially the same procedure that was used in 1930 to differentiate between cod liver oil and irradiated ergosterol, *i.e.*, the administration to chickens of materials previously assayed with rats. A precision method of assay with chickens, which will be described elsewhere, was developed to measure the response of this species with accuracy comparable to that attained in the critical method with rats.

The first experiment was done with oil extracted from the livers of halibut, ***Hippoglossus hippoglossus***. This was assayed with rats, and diluted with maize oil. The dilution was administered to chickens in parallel with cod liver oil of the same potency. Rat unit for rat unit, the halibut liver oil induced slightly less calcification in the chickens than did cod liver oil, but the difference was perhaps no greater than the errors of assay. We were left with the suspicion that a greater difference might be observed in other oils.

Compared with certain liver oils, cod liver oil is a weak source of vitamin D, containing usually about 100 international units per gm. Halibut liver oil contains on the average about 1,200 I. U. per gm, but even this is weak in comparison with several other fish oils that we have examined. One of the more potent liver oils is that of the bluefin tuna, *Thunnus thynnus*, which contains on the average 40,000 I. U. of vitamin D per gm. A pure specimen of this oil was assayed with rats, diluted and administered to chickens as before. Rat unit for rat unit, it was only one sixth as effective as cod liver oil. Similarly, the unsaponifiable fraction of the tuna liver oil was found to be one seventh as effective, rat unit for rat unit, as the unsaponifiable fraction of cod liver oil.

The effectiveness ratio which was thus found to be 1:6 or 1:7 is several times greater than the probable error of the assays. One must therefore conclude that the vitamin D of bluefin tuna liver oil and the vitamin D of cod liver oil are different substances (or different mixtures of substances), one rat unit of the former having only 15 per cent. of the antirachitic effectiveness of one rat unit of the latter *for the chicken*. A detailed account of these experiments will be published elsewhere, together with data on additional liver oils.

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BOOKS RECEIVED

DALY, REGINALD A. *The Changing World of the Ice Age*. Pp. xx + 271. 149 figures. Yale University Press. $5.00.

HENDERSON, YANDELL. *A New Deal in Liquor: A Plea for Dilution*. Pp. 239. Doubleday, Doran. $2.00.

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